SCIENCE AND THE COMMON FARMER[1]

We read and we see much, in these times, of the dependence of great industries on science. In fact many great industries have been established on recent scientific discoveries and developments. The relation of the common man to science is not so clearly recognized, and in the less progressive countries no such relation may exist. In the Orient for instance, the common farmer may be still getting along after a fashion with the same methods that he has been using for 4,000 years, and with practically no improvement either in his crops or in his mode of life.

"Science" is merely a seeking of the truth—the complete, unmistakable, indubitable facts—full and clear knowledge of all factors. Through science have come the modern possibilities of better culture, of plant breeding, of fertilization to suit crops and soils—all meaning larger returns for the unit area, and more generous returns, with far greater possibilities for the unit of human labor. From science has come great possibilities in crop insurance against pests and diseases, which up to a few decades ago did not exist in any country and is now developed in but few.

Uncontrolled Nature demands a fearful toll from the ignorant farmer. Here in the Philippines we lose each year some millions of pesos from pests and diseases, yet adequate support for investigation along these lines is unobtainable. By expenditure *through the right hands* of a few thousands, Hawaii Territory is constantly averting losses that might easily, if neglected, run into millions. Japan claims over-population and inability to produce at home adequate food supplies, but at the same time she allows too large a percentage to pests and diseases and does not support adequate investigation, her few over-worked specialists being unable to cope with existing problems for the whole country. Though it must be admitted that, under the highly efficient administration of Doctor Kuwana, Japan maintains the best plant quarantine service in the Orient. China has practically nothing along these lines and suffers tremendous losses accordingly, but the fate of the common man means little in China—as yet. Indo-China has but limited service of this sort, and Siam and the British Malayan colonies

[1]General contribution from the College of Agriculture No. 165.

nothing worthy of the name. In striking contrast, Java maintains a very active Institute for Plant Diseases where the highest class work is constantly in progress. Java also has, besides this, numbers of the highest class specialists obtainable, in the various cognate lines.

We talk of the material development of the Philippines as if it was a matter only of business—of attraction of capital. We should not forget what the years have clearly taught in America and Europe, that there can be in the long run no safety whatever in agriculture investment, without the essential technical—scientific—service that may throw new light on every problem, and may furnish the only reasonable insurance and security that agriculture—"the greatest gamble on earth"—may have. *After* needed and adequate knowledge *is secured,* it must then be taught to the whole population through every educational means available from lowest to highest.

This road is the only "royal road to wealth and well-being"—a pathway broad, plain, and clearly sign-posted. In the Orient, to a very large extent, we wander in meandering and tortuous by-paths that lead to no positive results. More needed, than all the political arguing and self-seeking, is constructive action that will result in putting us on the right road—in the way of definite material progress for the *common man* and of *hope* for all!

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"THE RESEARCHER"

Little of fame they get for it,
  And poor they live—and die.
Knowledge they seek and sweat for it
  That the world may gain thereby.
The world that learns but tardily,
  And grudgingly, too, in sooth;
While ever these pedants hardily
  Fare forth on the trail of truth!

—BERTON BRALEY

BRANCHING IN COCONUT[1]

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WITH TEN TEXT FIGURES

INTRODUCTION

This paper is a response to a call from Doctor Burkill (1923) formerly Director of the Singapore Botanical Gardens, Straits Settlements, for cases of branching in coconut (*Cocos nucifera* L.) outside of his territory, or territory mentioned by other authors.

No case of branching in coconut in the Philippines was recorded in the literature consulted by the writer. In the present paper seven cases of true branching in the Philippines are reported. It is assumed by many authors that branches are generally sterile, but the majority of cases here cited are of fertile branches.

At an Agricultural Fair held on the College of Agriculture Campus, University of the Philippines, two years ago, the municipality of Nagcarlang, province of Laguna, exhibited a coconut seedling with five shoots. The origin of the extra shoots could not be ascertained; whether it was a case of polyembryony or a case of premature branching or a case of both polyembryony and complete development of the three ovules, could not be determined as the owner would not donate the specimen for critical study. In the Carnival held in Manila from January 31 to February 14, 1926, three seedlings of coconut (figure 1) were exhibited by the province of Palawan. The first seedling had two shoots; the second seedling, three shoots; and the third seedling, five shoots. It is to be regretted that the specimens could not be procured for dissection and critical study; but judging from the position of the shoots, the origin of the extra shoots, with the exception of the third seedling could be ascertained with certainty. The first seedling evidently had two fertile ovules; in the second seedling, all three ovules were functional. The origin of the extra shoots of the third seedling could not be determined. Cases of polyembryony and premature

Figure 1.—Three coconut seedlings: (*a*) with two shoots; (*b*) with three shoots; (*c*) with five shoots.

[1] Experiment Station contribution No. 359. Received for publication, January 27, 1926.

branching have been reported by Forbes (1879), Costerus and Smith (1896) and (1923), and Mell (1923).

The branching is not restricted to seedlings, only, instances are numerous where mature coconut trees have branches. Andy (1870) reported a dichotomous division of a coconut palm caused by burrowing insects. Forbes (1879) during his visit to Cocos, or Keeling Island, in the South Indian Ocean, examined a coconut palm with branches. The tree instead of producing inflorescences as usual, developed branches, numbering 25 living, and 52 scars. Ridley (1907) noted a remarkable case of branching on Perseverance Estate in Singapore. From a main single stem three branches were formed. The central branch, which he thought to be the main bud,

Figure 2.—A coconut palm with five branches.

Figure 3.—Closer view of coconut shown in figure 2; some branches bearing nuts.

branched again and both died. The remaining two branches grew tall and each branched once more in a bifurcating manner. "One branch died, the other went on growing and branched again. Again one branch died and the other continued to develop, and this happened alternately, every alternate branch dying. In fact the growth is in this case cymose." All branches were sterile and showed no signs of having been attacked by insects or having been otherwise injured. Hunger (1920) in his book shows branched coconut trees with fruits. Munro and Brown (1920) presented a photograph

of a coconut tree with five branches, four with fruits. Costerus and Smith (1923), studying teratological cases of plants in the Tropics, reported a coconut tree at Tjetis near Ponorogo, which had forked twice. Henry (1920) mentioned a coconut palm, twenty years old, planted on the seashore of the island of Uk-Uka which had become distinctly forked, both branches being fertile. La Gorce (1924) in his article, "Porto Rico, The Gates of Riches," gives an illustration of a portion of a coconut palm (p. 269), showing branching. He called it "a finger growth of branches on a coconut palm." No description is given. Judging from the photograph the top of the tree was mutilated or destroyed and from it six fertile branches appeared. The picture shows that only five branches remained, one having died. Furtado (1924) mentioned Morris, Scott, and Henry as reporting branches bearing fruits from Fiji Islands, Calcutta, and Marquezas Islands, respectively. Furtado cited a case in Penang which had six branches, each of which had nuts. Burkill (1923) gave an account of a forked coconut palm in Geylang on the land adjoining the Perseverance Estate, which used to be fertile but at the time the paper was written was sterile. He also mentioned a tree in Penang Island with seven fertile branches, and another one in the outskirts of the village of Bachok, Kelantan, which at one time had fourteen branches, five of which died. Morris (1893) listed the tribes and genera of palms in which branched stems occurred. Most cases of branching in coconut have been summed up by him. He reported cases from Dornock Pen, Jamaica, and instances in which branched coconut palms have been noticed.

The writer is under deep obligation to Mr. Emilio Quisumbing, Chief, Irrigation Division, Bureau of Public Works, Philippines, for the assistance given in securing some of the data herein reported and also for some of the photographs.

BRANCHING COCONUT

Pangasinan Province. A branching tree is on the Macabito-Benlag Road, between kilometer posts No. 229 and 230, in the barrio of Macabito, municipality of Calasiao, province of Pangasinan. At the time of writing (1926) the tree is about forty-five years old, according to information given by the owner. When photographs were taken (fig. 2 and 3) the tree had five branches. It measured 11.5 meters from the ground to the base of the lowest branch. The largest branch was 3 meters long. According to the owner, in 1914, the tree formed a thick crown with short leaves and failed to produce fruits. Nine months later, the branches were noticed. In the first year only one branch produced fruits. After that year, the writer was told that all branches had fruited, not exceeding two on each branch at a time.

The history of the branching of this tree could not be accurately ascertained, but judging from its mode of branching the terminal bud must have been injured. Later branching could be ascribed, with probability, to the direct stimulation of the first branching. From the initial injury two

branches (figure 4, *a* and *b*) were borne. Branch *b* further branched dichotomously and produced branches *c* and *d*. Branch *a* later branched dichotomously producing branches *e* and *f*. Branch *f* continued to grow without branching but branch *e* produced branches *g* and *h*.

Rizal Province. Two trees, one with two branches and the other with three branches, were noted in Rizal Province. Both trees were found about 30 meters from the east bank of the Mariquina River, about 100 meters south of the Mariquina Bridge, in the barrio of Sta. Elena, municipality of Mariquina, province of Rizal. Both trees were estimated by the owner to be about 40 years old. The height from the ground to the base of the lowest branch was about two meters. No. 1 tree (figure 5) had three branches, all fertile; and No. 2 tree (figure 6) had two branches, one bearing fruit and the other one sterile during the time of the observation. The branching of these trees occurred 15 years ago. According to information furnished, branching was due to beetles. The trees were once infested by beetles, and to get rid of them, the owner poured kerosene on the tops of the trees and set fire to it. The leaves were scorched, and for a time showed signs of death. But after some time the owner was surprised to see branches forming.

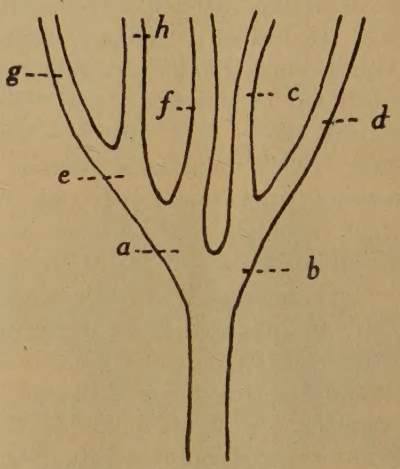

Figure 4.—Diagram showing mode of branching of the tree in Macabito, Pangasinan Province

Oriental Negros Province. A branching tree is located about 10 meters from the Larena-Siquijor Road, between kilometer posts 7 and 8; in the barrio of Candanay, in the municipality of Siquijor, sub-province of Siquijor, province of Oriental Negros. The tree (figure 7) was planted in 1883, and is now about 43 years old. The height from the ground to the base of the lowest branch is about 10 meters. Four branches were produced, two dead and two living. Branching of the tree occurred in 1904. The tree was attacked by beetles, and remained some time with all leaves dried. Later, two small branches were noted, then two more. All grew to about a meter in length. A hard storm broke off two of the branches, leaving only two, (figure 7). These two branches are both fertile.

Cebu Province. Three cases of branching were observed in this province, and will be designated here as Case No. 1, Case No. 2, and Case No. 3.

Case No. 1: The tree (figure 8) is located between kilometers 106 and 107, in the barrio of Matutinao, in the municipality of Badian, province of Cebu. It is 10 meters from the provincial road running from Matutinao

to Madredijos. The tree is 21 years old. It measured five and a half meters from the ground to the base of the lowest branch. In March, 1912, the tree was destroyed when it was two and one-half meters high. Later a shoot appeared, and this branched dichotomously at the height of three and three-fourths meters. The left branch died, and at the time the photograph was taken it had but one living branch. Branching occurred, according to the owner, in December 1916. The cause of the branching could not be ascertained. The owner stated that early in 1918, the tree showed signs of dying; all the leaves withered. Later on, young leaves

Figure 5.—Branching coconut palm from Rizal Province, with three fertile branches.

Figure 6.—Branching coconut palm from Rizal Province; one branch bearing fruits and the other sterile.

developed, and then flower clusters which, instead of developing into flowers, produced leaves. Two branches were apparently developed this way, through the failure of the two inflorescences to develop. Fruits were said to have been formed but did not develop to maturity, falling at an early stage. The owner also told the writer that he had seen another branched coconut near kilometer 74, near the town of Dumanjug, in the same province. It is located about 300 meters from the provincial road running from Dumanjug to the town of Ronda. No photographs were taken, but the informant mentioned that the tree was fertile on two branches.

Figure 7.—Branching coconut palm from Oriental Negros Province; showing four branches, two dead and two living.

Figure 8.—A branched coconut palm, showing only one living branch.

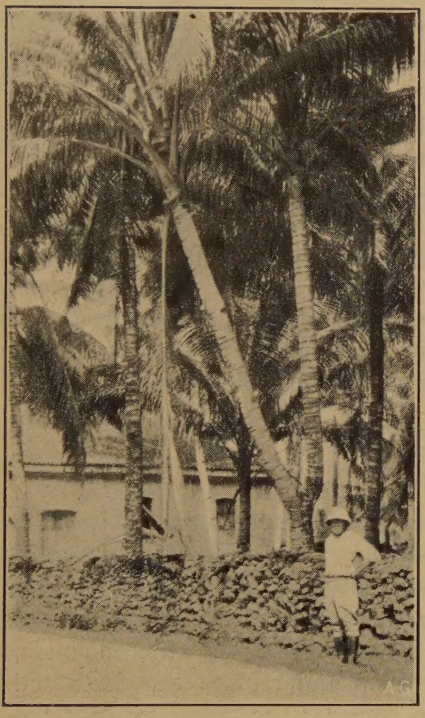

Figure 9.—A branched coconut palm, showing two sterile branches.

Figure 10.—A branched coconut palm with two fertile branches.

Case No. 2: The tree (figure 9) was found in the municipality of Talisay, in the province of Cebu, on land belonging to the Government, where the office of the Friar Lands Agent's office is located. The tree is approximately 17 years old, having been planted in 1909. The height from the ground to the base of the lowest branch was 2.10 meters. The left branch was 5.5 meters long and the right branch, 5.3 meters long. Branching occurred in 1916. The cause of the branching could not be ascertained, but in 1916 the leaves became shorter and it was thought that the tree would die; but a few months later two young shoots appeared, and the branches began to grow. The owner of the tree stated that it was suspected that bud-rot was responsible for the branching. The tree has never flowered.

Case No. 3: The tree (figure 10) is located on the right side of the Cebu South Road, between kilometers 125 and 126, in the barrio of Luka, municipality of Oslob, province of Cebu. The tree is said to have been planted in 1917. It measured two meters from the ground to the base of the lowest branch. The left branch was 33 cm. long and the right branch, 21 cm. The growth of the tree was normal until 1921 when the crown was attacked by beetles. After the attack, the tree showed signs of dying Later, the owner was surprised to see two shoots appearing, which developed into branches as shown in figure 10. Both branches are said to be fertile, and at the time the photographs were taken they had fertile flowers. Fruits had been harvested in the past.

DISCUSSION

From search in the Philippines it appears that branching in the coconut is of occasional occurrence. The seven cases herein reported may be ascribed, apparently, to attacks of insects or destruction of the terminal bud by strong wind or the failure of the inflorescences to form flowers. When the terminal bud is injured there seems to be a tendency for the adjacent buds, probably axillary or adventitious, to develop and replace the destroyed terminal bud. This is possible when we consider the possibilities of the inflorescences failing to develop into flowers and fruits, instead producing branches. This is also possible when we consider that flowers are metamorphosed leaves. There seems to be a tendency also in the coconut to continue branching in a dichotomous manner, after the terminal bud is destroyed. This is true in some cases (figures 2 and 3), but apparently not so in other cases (figure 9), in which the tree after forking once, ceased to fork further.

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EFFECT OF COMMERCIAL FERTILIZERS ON LOWLAND AND UPLAND RICE[1]

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INTRODUCTION

The rice soils in the Philippines are fast becoming depleted of essential food elements; our system of rice farming is wasteful. Every crop takes out of the soil enormous amounts of plant foods, consequently, the unfertilized rice soils are poorer now than they were some years ago. This condition is no doubt one of the causes of low production. If the Filipino farmers do not return from time to time the food elements taken from the soil, it will not be long before rice farming in many parts of the Islands will cease to be profitable. The Filipino farmers need not go to the extreme of using night soil for manuring as is practiced in China, Korea, and Japan, but something must be done in the manuring of our rice soils if the production of rice is to continue to be encouraging.

Kelley and Thompson (1910) report that the rice plant removes the following amounts of plant foods from one acre:

	Nitrogen		*Phosphoric acid*		*Potassium*	
	lb.	(*kgm.*)	*lb.*	(*kgm.*)	*lb.*	(*kgm.*)
Roots	2.2	(1.0)	3.3	(1.5)	2.9	(1.3)
Stems	10.1	(4.5)	3.6	(1.6)	71.8	(37.1)
Leaves	6.9	(3.1)	1.9	(0.8)	15.9	(7.2)
Chaffs	5.1	(2.3)	3.2	(1.4)	11.2	(5.0)
Grains	44.1	(2.1)	30.0	(13.6)	14.1	(6.4)
Total	64.4	(13.0)	42.0	(18.9)	115.9	(57.0)

These investigators (1910) figured out that the rice grain contains 1.22 per cent of nitrogen, 0.83 per cent of phosphoric acid, and 0.39 per cent of potassium. Considering that the production of rice in the Philippines for the year ending June 30, 1924, was 41,570,700 cavans (1,787,540,100 kgm.) of palay (crop statistics issued by the Philippine Bureau of Agriculture, 1925) this production must have taken from the rice soils of the Islands 507,162 cavans (21,807,966 kgm.) of nitrogen, 345,036 cavans (14,836,548 kgm.) of phosphoric acid and 162,225 cavans (6,975,675 kgm.) of potassium.

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The writer expresses his indebtedness to Dr. R. B. Espino of the Plant Physiology Department for suggestions during the progress of the experiment.

Putting the price of nitrogen at 30 centavos a kilogram, phosphoric acid at 13 centavos, and potassium at 10 centavos this loss would amount to the following large sums:

Essential plant foods	*Amounts of plant foods lost*	*Estimated value of loss*
	kgm.	*pesos*
Nitrogen	21,807,966	6,542,389
Phosphoric acid	14,836,548	1,928,751
Potassium	6,975,675	697,575
Total	43,630,189	9,169,716

Past work

Zamora (1911) conducted fertilizer experiments in rice pots, using 21. He soaked the pots in coconut oil to prevent the evaporation of water and loss of salts through the walls of the pots. In each pot, he put about one kilogram of soil which was a mixture of two parts loam and one part sand. He applied $(NH_4)NO_3$, K_2HPO_4, $CaH_4(PO_3)_2$, $MgCl_2$, $MgNO_3$, and $MgSO_4$, all salts being chemically pure. He concluded that in the rate of growth and in number of grains set, the control plants were far behind any of the plants in the fertilized pots, and that the best three salts ranked as follows: first, NH_4NO_3, second, $KH_2(PO_4)_2$, and third, $CaH_4(PO_4)$.

Villegas (1912) grew rice in water culture with and without extracts from cogon and from bamboo soils in the presence of nitrogen compounds. The cogon and bamboo soils are known to be hard on other crops. He reported that cogon and bamboo soils contain substances toxic to rice in acid media and that the growth of the rice was stimulated in every case where sodium nitrate was applied.

Balangue (1916) conducted fertilizer experiments using wood ashes and horse manure, singly and in combination. He used lime also. He found that of the locally available fertilizers, horse manure was the best, ashes next best, and that the combination of horse manure and ash was needed by rice soils. He also found that liming worn out rice soils increases rice production.

Mendiola (1919) reports that A. A. Goco "tried to determine the advantages to be derived from the application of fertilizers combined with selection," and that "the yield obtained by the application of fertilizers may be increased by the use of selected seed."

Enormous amounts of wood ashes, herbage, and human waste are applied to rice fields in China, Japan, and Korea. Rice straw, rice chaff, any material fit for incorporation with the soil is made use of. Because of the density of population, the people are forced to practice the most intensive system of rice farming. According to King (1911) Japan applied to her fields in 1908, 23,850,295 tons of human manure, 23,812,787 tons of com-

post, 753,074 tons of commercial fertilizers, 1,404,000 tons of fuel ash and 10,185,500 tons of green products. These materials were applied to less than 14,000,000 acres of cultivated land.

This authority commenting on the loss of plant foods from rice fields, states that rice removes from the soil per 1,800 pounds of dry weight, 9.949 pounds of nitrogen, 1.129 pounds of phosphorous, and 6.089 pounds of potassium.

Kelley (1914) conducted a series of fertilizer experiments in lowland fields in Hawaii for seven consecutive crops using superphosphate, potassium sulfate and ammonium sulfate. He used the fertilizers singly and in combination. He concluded that potassium and phosphoric acid were without effect, that the application of ammonium sulfate at the rate of 150 pounds per acre produced notable increases in yield, and that the application of 300 pounds of this salt to the acre was more profitable.. He also concluded that complete fertilizer was no more effective than ammonium sulfate alone.

In an earlier fertilizer experiment, Kelley (1911) made use of calcium nitrate, magnesium nitrate, sodium nitrate, ammonium sulfate, soybean cake, sodium nitrate and ammonium sulfate in four applications. The experiment was conducted in flasks, pots, and fields. Sand cultures were also made. There were dry land and wet land series. Kelley found that the application of ammonium sulfate produced considerable increases in the yield of straw and grain of rice, while sodium nitrate was ineffective. The application of ammonium sulfate before planting gave greater yields than were produced by the applications at intervals during the growth of the crop. Nitrate of soda produced little effect, however applied. This was the result in the field experiment.

In the pot experiment, nitrate was without effect until near the heading period. Nitrates applied before planting produced only a little increase. Greater yields were obtained from the application of nitrates at intervals. Soybean cake produced considerable increase in the growth of rice. Ammonium sulfate was the most effective of all. It brought about more tillering, hence, more fruiting stems.

Denitrification was found to take place in rice paddies. Nitrates and free nitrogen were formed from the nitrates. In the flask experiment, it was proved that denitrification was active enough to account for the loss of nitrates, and that ammonification takes place to a considerable extent in submerged rice soils.

In the sand culture experiment, it was found that if the rice had access only to nitrates as the source of combined nitrogen, unhealthy and stunted growth followed. Ammonium salts brought about vigorous growth. Kelley, therefore, recommends the use of ammonium and organic nitrogen and not nitrates for fertilization of rice fields.

Cox (1911) determined the chemical compositions of a worn out soil on the Government rice farm at Murcia, Tarlac, and first class rice soils in two places in Cavite Province. He found that the nitrogen content of the Murcia soil was only 0.072 per cent in the surface and 0.042 per cent in the sub-surface; the phosphorous content was 0.082 per cent in the surface and 0.052 per cent in the sub-surface. There were no figures given for potassium. One of the rich rice soils of Cavite contained 0.121 per cent of nitrogen; the other, 0.153 per cent. The phosphoric acid content of the first soil was 0.077 per cent and the second, 0.110 per cent. The potash content of the first soil was 0.17 per cent, and of the second, 0.20 per cent.

In his book, *The Soils*, Hilgard states that a soil to be profitable for farming should contain at least 0.25 per cent of K_2O, 0.05 per cent of P_2O_5, and 0.10 per cent of nitrogen. In the same book, Hilgard gives Voltham's standard as follows:

	Very rich soil	*Good soil*	*Soil inadequately supplied*
	per cent	*per cent*	*per cent*
K_2O.....	0.2	0.1	0.05
P_2O_5.....	0.2	0.1	0.06
N.....	0.2	0.1	0.05
CaO and MgO.....	1.0	0.4	0.07

It is shown very clearly that the essential food element content of the soils at Murcia were below that standard, while the soils in Cavite contain essential plant food elements comparing favorably in amounts with the standard.

Trelease and Jurado (1920) studied the effect of addition of three-salt solutions of primary calcium phosphate $Ca(H_2PO)_2$, ammonium sulfate $(NH_4)_2SO_4$, and potassium sulfate K_2SO_4 on the growth of rice in a water saturated soil. It was found that the yield of straw and grain was positively correlated with the ammonium sulfate concentrations in the solutions. The concentration of primary calcium phosphate and potassium sulfate had no relation to yield of grain and straw. This finding corroborates that of Trelease (1920) in his experiment on the three-salt solutions using the same kinds of salts.

Trelease and Paulino (1920) conducted experiments on the three-salt solution plan using primary calcium phosphate, potassium sulfate and a nitrogenous salt. They used four different kinds of nitrogenous salts; namely, ammonium sulfate $(NH_4)_2SO$, ammonium nitrate $(NH\,NO_3)$, calcium nitrate, $Ca(NO_3)_2$ and sodium nitrate, $NaNO_3$. The aim of the experiment was to compare the effect of nitrogenous salts on the yield of rice in water cultures. There were four groups of cultures. In each group a different form of nitrogen was applied. They found no correlation between

yield of grain and straw and the concentrations of either primary calcium phosphate and potassium sulfate, but a strong correlation between any of the nitrogenous salts and yield of straw and grain. The best culture supplied with ammonium sulfate gave a yield of 9.6 times the yield of the control; that of ammonium nitrate, 6.5 times; that of calcium nitrate, 3 times; and that of sodium nitrate, 3.2 times. The effect of ammonium nitrogen was very marked. The effect of nitrate nitrogen, although slight, can not be disregarded.

Espino (1920) in his investigation made in the Johns Hopkins University Plant Physiology Laboratory green-house at Baltimore to determine the salt requirements of young rice plants used three types of solutions; namely, (*a*) a three-salt solution containing monopotassium phosphate, calcium nitrate and magnesium sulfate with a trace of ferric phosphate; (*b*) a four-salt solution, Type A, containing the three salts mentioned above and ammonium sulfate with a trace of ferric phosphate; and (*c*) a four-salt solution containing monopotassium phosphate, monocalcium phosphate, magnesium sulfate and ammonium sulfate with a trace of ferric phosphate. He germinated the rice seeds (variety, Wateribune from Louisiana) in tap water and grew the seedlings in water cultures containing those three types of salt combinations. He determined the dry weight of the tops, the dry weight of the roots, the green weight of the tops, the total absorption, the length of the tops and the length of the roots. He concluded that no set of salt solution of the three-salt type gave a fair growth. He obtained an excellent growth from the four-salt solution, Type A, containing the ammonium ion. He found the four-salt solution, Type B, to be not suited to young rice plants, and expressed the idea that young rice plants require both the ammonium and the nitrate ion.

Object of the present work

The objects of the present work were to determine: (*a*) the effect on rice of different kinds of fertilizers applied singly and in combination, (*b*) the effect on rice of different amounts of sodium nitrate, ammonium sulfate, and dried blood applied alone and in combination with other fertilizers, and (*c*) the minimum and maximum application of sodium nitrate, ammonium sulfate, and dried blood when applied singly and when applied with other fertilizers.

Time and place of work

This experiment was conducted at the College of Agriculture during the rice season of 1920-1921. The season was without typhoons, and was very favorable for the growth of the rice.

MATERIAL AND METHODS

Two varieties of rice were the subject of this experiment, a lowland variety named Caviteña, and upland variety named Tiniaong. Both varieties mature in about 100 days.

Petroleum cans were used as receptacles. Into each can about 20 kilograms of air-dry soil was placed; this filled the can to within about 8 centimeters of the top. The soil was taken from a uniform lot at the left side of the road entering the College of Agriculture grounds. Cox (1911) determined the chemical composition of this soil and found it to contain 0.126 per cent of nitrogen, 0.196 per cent of phosphoric acid, and 0.321 per cent of potassium. His analysis showed no calcium nor magnesium. The writer determined the chemical composition of this soil also and found only traces of calcium and magnesium. Cox's analysis was made some years ago. The soil, having been cropped continuously since Cox made his determination, it must be much poorer now than it was in 1911.

The fertilizers used for this experiment were kainit, superphosphate, sodium nitrate, ammonium sulfate, and dried blood. These are the kinds of commercial fertilizers that are found generally on the market. Lime was also used. The fertilizers were thoroughly mixed with the soil to a depth of about 12 centimeters before the seedlings were transplanted in the cans. The amounts of the application are given in the tables.

The rice seeds were soaked in water over night, and then germinated in soil similar to that in the cans. In a week the seedlings, then about five centimeters tall, were transplanted in the cans, eight seedlings to a can. The seedlings were thinned later to six or four. (See tables 1-11).

The lowland rice was kept in water-saturated soil throughout the period of growth. The soil in the upland series was kept only moist, so as to simulate as much as possible upland conditions. Holes were made at the bottom of the can to drain off the excess of water. Sometimes it was difficult to secure perfect drainage due to the extra retaining power of the soil. This happens usually when there is continuous rain for some days. Effort was made to keep the plants well supplied with water throughout the growing season.

EXPERIMENTS AND RESULTS

The lowland series (results shown in tables 1 and 3) were planted September 11, 1920. The plants matured December 29, 1920, that is, in 109 days. Two sets of plantings were made for the upland series, the first set being planted September 11, 1920. The plants matured December 8, 1920, in 88 days. The results of this series are given in tables 2, 4, and 11. The second set of upland series (results shown in tables 5, 6, 7, 8, 9, and 10) were planted October 28, 1920. The plants matured February 8, 1921, in 73 days. The second set of the upland series was planted rather late in the season. This lateness of planting is no doubt responsible for the reduction of the days required by the variety (Tiniaong) to mature.

It was observed that nitrogenous fertilizers retarded the maturity of the crop from three to ten days, depending on the amount applied. The more the amount of fertilizers applied the more were the days of retarda-

tion. This phenomenon was especially true with ammonium sulfate and sodium nitrate. The other fertilizers had practically no effect on the days of maturity.

Tables 1-11 show the applications of fertilizers, their kinds, amounts, and proportions; and also the results of the experiments. It will be found that efforts were made to show the application and the results of each series of experiment in one table. All weights given are air-dry weights.

TABLE 1

Showing the effect of mixed fertilizers on Caviteña, a variety of lowland rice

CAN NO.	FERTILIZERS APPLIED				NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	Kainit	Superphosphate	Dried blood	Lime							
	grams	*grams*	*grams*	*grams*			*cm.*			*grams*	*grams*
1a...	17.5	17.5	87.5	17.5	5	40	105.5	4	36	117.0	7.5
1b...	17.5	17.5	87.5	17.5	6	35	88.4	10	30	156.4	11.9
2a...	17.5	52.5	52.5	17.5	6	37	98.5	11	26	116.5	6.2
2b...	17.5	52.5	52.5	17.5	6	52	87.5	9	43	115.5	9.1
3a...	17.5	87.5	17.5	17.5	5	31	101.9	9	22	86.2	10.4
3b...	17.5	87.5	17.5	17.5	6	31	98.4	11	20	94.9	9.0
4a...	52.5	17.5	52.5	17.5	6	33	121.9	12	21	103.8	7.0
4b...	52.5	17.5	52.5	17.5	5	35	116.3	16	19	136.2	16.4
5a...	52.5	35.0	35.0	17.5	6	26	102.5	10	16	83.4	11.2
5b...	52.5	35.0	35.0	17.5	6	37	100.1	19	18	132.0	19.4
6a...	52.5	52.5	17.5	17.5	5	28	92.7	9	19	74.4	17.5
6b...	52.5	52.5	17.5	17.5	6	25	98.3	10	15	72.8	23.6
7a...	87.5	17.5	17.5	17.5	6	18	114.1	8	10	57.8	10.7
7b...	87.5	17.5	17.5	17.5	6	28	83.4	18	16	61.6	9.8
8a...	17.5	17.5	70.0	35.0	5	35	112.5	24	11	120.3	28.9
8b...	17.5	17.5	70.0	35.0	6	34	118.3	23	11	157.4	36.5
9a...	17.5	70.0	17.5	35.0	6	25	107.3	15	10	75.6	18.1
9b...	17.5	70.0	17.5	35.0	6	25	102.8	11	14	75.4	18.3
10a...	35.0	35.0	35.0	35.0	6	33	111.6	13	20	135.0	10.1
10b...	35.0	35.0	35.0	35.0	6	29	106.4	13	16	87.2	24.6
11a...	70.0	17.5	17.5	35.0	6	20	108.0	8	12	81.3	5.7
11b...	70.0	17.5	17.5	35.0	6	20	111.5	5	15	70.7	2.9
12a...	17.5	17.5	52.5	52.5	6	40	104.0	18	22	161.0	11.8
12b...	17.5	17.5	52.5	52.5	6	40	96.5	14	26	137.4	32.2
13a...	17.5	52.5	17.5	52.5	5	31	89.8	12	19	69.7	11.0
13b...	17.5	52.5	17.5	52.5	6	29	83.3	6	23	72.7	16.8
14a...	52.5	17.5	17.5	52.5	6	34	84.5	9	25	80.5	7.4
14b...	52.5	17.5	17.5	52.5	6	30	85.0	10	20	73.5	7.0
15a...	35.0	17.5	17.5	70.0	6	34	79.1	9	23	61.3	3.8
15b...	35.0	17.5	17.5	70.0	6	29	86.4	8	21	78.6	3.5
16a...	17.5	17.5	17.5	87.5	6	25	91.4	7	18	71.6	4.5
16b...	17.5	17.5	17.5	87.5	6	26	100.6	13	13	100.2	5.3
17a...		Control			6	20	71.0	6	14	37.5	3.4
17b...		Control			6	14	82.5	8	6	40.0	4.0

TABLE 2

Showing the effect of mixed fertilizers on Tiniaong, a variety of upland rice

CAN NO.	FERTILIZERS APPLIED				NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	Kainit	Super-phos-phate	Dried blood	Lime					
	grams	*grams*	*grams*	*grams*			*cm.*	*grams*	*grams*
1a	17.5	17.5	87.5	17.5	6	30	96.20	61.1	52.0
1b	17.5	17.5	87.5	17.5	6	41	96.13	76.2	44.7
2a	17.5	52.5	52.5	17.5	6	33	99.26	64.1	44.6
2b	17.5	52.5	52.5	17.5	6	29	102.84	54.4	35.6
3a	17.5	87.5	17.5	17.5	6	18	94.49	40.7	20.0
3b	17.5	87.5	17.5	17.5	6	24	102.78	42.1	30.2
4a	52.5	17.5	52.5	17.5	6	29	103.43	57.2	46.7
4b	52.5	17.5	52.5	17.5	6	25	103.85	48.6	38.7
5a	52.5	35.0	35.0	17.5	6	23	98.07	38.7	30.2
5b	52.5	35.0	35.0	17.5	6	29	111.20	58.0	46.2
6a	52.5	52.5	17.5	17.5	6	23	87.77	30.7	25.0
6b	52.5	52.5	17.5	17.5	6	21	99.96	38.5	29.8
7a	87.5	17.5	17.5	17.5	6	13	100.00	19.7	13.8
7b	87.5	17.5	17.5	17.5	6	14	92.29	19.8	15.5
8a	17.5	17.5	70.0	35.0	6	36	110.33	100.3	82.7
8b	17.5	17.5	70.0	35.0	6	25	110.06	69.2	53.1
9a	17.5	70.0	17.5	35.0	6	28	95.13	29.2	23.3
9b	17.5	70.0	17.5	35.0	6	18	102.29	61.6	22.8
10a	35.0	35.0	35.0	35.0	6	28	101.48	48.2	39.5
10b	35.0	35.0	35.0	35.0	6	26	95.60	84.4	33.4
11a	70.0	17.5	17.5	35.0	6	14	91.46	20.7	13.7
11b	70.0	17.5	17.5	35.0	6	17	9 .06	24.6	17.1
12a	17.5	17.5	52.5	52.5	6	40	106.53	42.6	56.1
12b	17.5	17.5	52.5	52.5	6	29	106.86	58.3	49.2
13a	17.5	52.5	17.5	52.5	6	14	79.79	18.2	36.2
13b	17.5	52.5	17.5	52.5	6	27	101.97	53.5	46.0
14a	52.5	17.5	17.5	52.5	6	21	98.84	44.4	21.4
14b	52.5	17.5	17.5	52.5	6	27	99.01	46.2	31.8
15a	35.0	17.5	17.5	70.0	6	18	86.66	29.1	14.9
15b	35.0	17.5	17.5	70.0	6	20	80.88	28.3	11.1
16a	17.5	17.5	17.5	87.5	6	26	91.86	42.6	34.3
16b	17.5	17.5	17.5	87.5	6	15	85.61	18.1	17.1
17a		Control			6	9	74.00	19.4	17.2
17b		Control			6	15	84.73	2.22	14.5

TABLE 3

Showing the effect of single fertilizers on Caviteña, a variety of lowland rice

CAN NO.	FERTILIZERS USED	TOTAL AMOUNT APPLIED	NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
		grams			*cm.*			*grams*	*grams*
18a	Kainit alone	140.0	6	24	78.4	2	22	32.0	0.0
18b	Kainit alone	140.0	5	18	81.8	6	12	42.2	0.7
19a	Superphosphate	140.0	6	25	102.5	11	12	68.6	13.8
19b	Superphosphate	140.0	6	27	103.2	15	12	70.3	15.6
20a	Dried blood	140.0	6	51	123.0	36	15	211.0	73.0
20b	Dried blood	140.0	6	56	105.6	32	24	179.5	49.0
21a	Lime alone	140.0	6	21	92.0	10	11	61.2	17.3
21b	Lime alone	140.0	6	18	90.3	11	17	44.8	16.5
22a	Sodium nitrate	140.0	1	3	30.9	0	1	5.0	0.0
22b	Sodium nitrate	140.0	1	11	66.0	0	11	20.0	0.0
23a	Amm. sulfate	35.0	6	60	105.7	12	48	173.8	15.6
23b	Amm. sulfate	35.0	6	107	104.1	34	73	340.0	30.0
24a	Amm. sulfate	70.0	3	32	91.0	2	30	62.0	0.0
24b	Amm. sulfate	70.0	4	56	98.4	11	45	157.0	0.9
25a	Amm. sulfate	140.0	6	56	93.1	6	50	111.3	0.0
25b	Amm. sulfate	140.0	6	73	78.4	2	71	184.8	0.0

TABLE 4

Showing the effect of single fertilizers on Tiniaong, a variety of upland rice

CAN NO.	FERTILIZERS USED	TOTAL AMOUNT APPLIED	NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
		grams			*cm.*	*grams*	*grams*
18a	Kainit alone	140.0	1	6	57.83	4.3	1.6
18b	Kainit alone	140.0	4	9	64.20	6.7	5.0
19a	Superphosphate	140.0	6	15	86.72	21.7	13.4
19b	Superphosphate	140.0	5	19	83.66	21.4	20.4
20a	Dried blood	140.0	6	39	99.86	79.2	70.0
20b	Dried blood	140.0	6	38	98.45	89.8	61.5
21a	Lime alone	140.0	6	15	87.88	19.5	16.0
21b	Lime alone	140.0	6	14	77.07	15.6	11.1
22a	Sodium nitrate	140.0	6	52	66.41	93.9	41.8
22b	Sodium nitrate	140.0	5	36	78.94	59.7	31.3
23a	Amm. sulfate	35.0	6	42	85.23	77.0	34.2
23b	Amm. sulfate	35.0	6	49	95.28	102.4	34.4
24a	Amm. sulfate	70.0	6	45	80.03	128.5	42.8
24b	Amm. sulfate	70.0	4	60	94.71	137.9	56.8
25a	Amm. sulfate	140.0	6	28	86.95	44.9	20.0
25b	Amm. sulfate	140.0	6	70	67.74	73.8	23.5

TABLE 5

Showing effect of dried blood with kainit, superphosphate and lime on Tiniaong, a variety of upland rice

CAN. NO.	FERTILIZERS APPLIED				NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	Kainit	Superphosphate	Lime	Dried blood							
	grams	*grams*	*grams*				*cm.*			*grams*	*grams*
1a.	17.5	17.5	17.5	17.5	4	16	64.58	12	4	18.3	8.3
1b.	17.5	17.5	17.5	17.5	4	14	74.32	13	3	18.6	12.8
2a.	17.5	17.5	17.5	35.0	4	16	79.41	15	1	19.9	16.1
2b.	17.5	17.5	17.5	35.0	4	14	64.76	10	4	27.5	28.5
3a.	17.5	17.5	17.5	52.5	4	20	79.47	17	3	30.0	28.1
3b.	17.5	17.5	17.5	52.5	4	14	74.78	10	4	24.5	28.8
4a.	17.5	17.5	17.5	70.0	4	19	84.26	17	3	35.9	30.4
4b.	17.5	17.5	17.5	70.0	4	29	87.20	21	8	47.5	34.3
5a.	17.5	17.5	17.5	87.5	4	24	86.20	21	3	44.5	43.2
5b.	17.5	17.5	17.5	87.5	4	18	88.44	17	2	30.7	26.7
6a.	17.5	17.5	17.5	105.0	4	19	56.72	14	5	36.9	27.8
6b.	17.5	17.5	17.5	105.0	4	29	73.65	23	6	54.4	31.0
7a.	17.5	17.5	17.5	122.5	4	28	80.33	22	6	34.2	30.7
7b.	17.5	17.5	17.5	122.5	4	27	76.20	22	5	49.8	42.7
8a.	17.5	17.5	17.5	140.0	4	26	80.14	18	8	43.6	27.6
8b.	17.5	17.5	17.5	140.0	4	24	82.41	21	3	48.5	45.5
9a.	17.5	17.5	17.5	157.5	4	25	91.12	21	4	44.2	37.5
9b.	17.5	17.5	17.5	157.5	4	29	83.98	22	7	61.1	49.8
10a.	17.5	17.5	17.5	175.0	4	35	84.73	31	4	68.1	51.1
10b.	17.5	17.5	17.5	175.0	4	27	75.01	24	3	56.1	49.6
11a.		Control			4	4	50.34	3	1	4.5	5.4
11b.		Control			4	11	63.83	9	2	11.4	8.3

TABLE 6

Showing the effect of different amounts of dried blood on Tiniaong, a variety of upland rice

CAN NO.	AMOUNTS OF DRIED BLOOD APPLIED	NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CSN
	grams			*cm.*			*grams*	*grams*
1a.	17.5	4	15	63.21	11	4	24.5	13.4
1b.	17.5	4	19	59.74	10	9	30.0	8.5
2a.	35.0	4	11	84.85	8	3	28.9	15.9
2b.	35.0	4	14	67.02	9	5	33.6	20.6
3a.	52.5	4	17	76.01	14	3	30.4	20.0
3b.	52.5	4	17	72.45	11	6	33.1	20.5
4a.	70.0	4	20	83.11	16	4	57.1	35.5
4b.	70.0	4	21	78.40	18	3	57.3	36.2
5a.	87.5	4	20	80.16	14	6	61.8	35.8
5b.	87.5	4	27	79.95	26	1	51.5	47.3
6a.	105.0	4	22	79.46	21	1	65.7	42.0
6b.	105.0	4	21	71.78	20	1	48.1	48.0
7a.	122.5	4	26	72.88	21	5	83.0	47.9
7b.	122.5	4	28	66.99	22	6	59.5	47.0
8a.	140.0	4	24	91.93	20	4	70.1	49.5
8b.	140.0	4	27	84.40	23	4	63.5	58.6
9a.	157.5	4	27	82.44	19	8	66.7	41.4
9b.	157.5	4	28	79.88	19	9	77.8	56.9
10a.	175.0	4	33	66.95	15	18	71.4	23.7
10b.	175.0	4	34	82.20	23	11	86.1	39.8

TABLE 7

Showing the effect of ammonium sulfate with kainit, superphosphate, and lime on Tiniaong, a variety of upland rice

CAN NO.	FERTILIZERS APPLIED				NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	Kainit	Superphosphate	Lime	Ammonimu sulfate							
	grams	*grams*	*grams*	*grams*			*cm.*			*grams*	*grams*
1a	17.5	17.5	17.5	2.1925	4	24	42.24	12	2	19.8	17.4
1b	17.5	17.5	17.5	2.1925	4	24	64.62	16	8	25.1	22.1
2a	17.5	17.5	17.5	4.3850	4	12	74.42	12	0	23.5	17.5
2b	17.5	17.5	17.5	4.3850	4	22	65.40	17	5	30.1	20.8
3a	17.5	17.5	17.5	7.7500	4	19	72.40	13	6	34.5	20.8
3b	17.5	17.5	17.5	8.7300	4	23	85.70	20	3	41.2	34.4
4a	17.5	17.5	17.5	17.5000	4	29	89.23	27	2	61.0	41.1
4b	17.5	17.5	17.5	17.5000	4	36	83.81	32	4	57.7	43.0
5a	17.5	17.5	17.5	35.0000	4	39	83.87	30	9	68.7	34.7
5b	17.5	17.5	17.5	35.0000	4	23	84.74	16	7	44.8	28.4
6a	17.5	17.5	17.5	70.0000	4	38	74.01	24	14	53.0	26.1
6b	17.5	17.5	17.5	70.0000	4	44	74.33	36	8	79.5	36.3
7a	17.5	17.5	17.5	140.0000	4	45	74.55	20	25	75.8	15.9
7b	17.5	17.5	17.5	140.0000	4	45	86.25	34	11	85.4	19.7
8a	17.5	17.5	17.5	210.0000	4	61	57.26	21	40	68.5	7.9
8b	17.5	17.5	17.5	210.0000	4	45	73.64	22	23	63.8	15.2
9a	17.5	17.5	17.5	280.0000	4	24	78.96	17	7	66.2	9.3
9b	17.5	17.5	17.5	280.0000	4	41	67.51	11	30	68.1	12.5
10a	17.5	17.5	17.5	350.0000	4	35	84.77	19	16	61.1	6.4
10b	17.5	17.5	17.5	350.0000	4	68	69.89	20	48	65.9	8.2
11a	Control				4	7	73.44	7	0	7.6	8.3
11b	Control				4	11	70.77	9	2	12.9	10.3

TABLE 8

Showing the effect of different amounts of ammonium sulfate on Tiniaong, a variety of upland rice

CAN NO.	AMOUNTS OF AMMONIUM SULFATE APPLIED	NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	grams			*cm.*			*grams*	*grams*
1a	2.195	4	21	76.84	15	6	30.8	22.5
1b	2.195	4	17	79.44	15	2	31.2	27.5
2a	4.385	4	17	87.46	14	3	38.5	31.7
2b	4.385	4	13	83.15	9	4	29.6	20.3
3a	8.75	4	27	83.20	18	9	50.4	41.4
3b	8.75	4	20	95.13	18	2	53.0	40.5
4a	17.50	4	35	76.30	21	14	56.3	34.1
4b	17.50	4	34	76.51	20	14	69.3	40.0
5a	35.00	4	23	66.31	9	14	28.3	8.0
5b	35.00	4	24	76.08	14	10	42.4	15.2

TABLE 9

Showing the effect of different amounts of sodium nitrate with kainit, superphosphate and lime on Tiniaong, a variety of upland rice

CAN NO.	FERTILIZERS APPLIED				NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	Kainit	Superphosphate	Lime	Sodium nitrate							
	grams	*grams*	*grams*	*grams*			*cm.*			*grams*	*grams*
1a	17.5	17.5	17.5	52.5	4	34	67.02	16	18	55.5	16.7
1b	17.5	17.5	17.5	52.5	4	30	71.62	19	11	52.7	18.6
2a	17.5	17.5	17.5	70.0	4	38	81.65	24	14	64.0	34.5
2b	17.5	17.5	17.5	70.0	4	31	72.92	18	13	44.6	35.9
3a	17.5	17.5	17.5	87.5	4	37	82.88	26	11	56.0	40.3
3b	17.5	17.5	17.5	87.5	4	25	56.80	4	21	52.9	32.6
4a	17.5	17.5	17.5	105.0	4	27	82.64	23	4	38.5	26.9
4b	17.5	17.5	17.5	105.0	4	40	62.55	12	28	47.2	24.1
5a	17.5	17.5	17.5	122.0	4	31	70.40	14	17	49.6	28.7
5b	17.5	17.5	17.5	122.0	4	28	78.04	23	5	41.6	34.2

TABLE 10

Showing the effect of different amounts of sodium nitrate on Tiniaong, a variety of upland rice

CAN. NO.	AMOUNTS OF SODIUM NITRATE APPLIED	NO. OF PLANTS AT MATURITY PER CAN	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	NO. OF BEARING CULMS	NO. OF NON-BEARING CULMS	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
	grams			*cm.*			*grams*	*grams*
1a	52.5	4	12	66.31	8	4	9.5	12.5
1b	52.5	4	13	68.07	12	1	10.6	12.5
2a	70.0	4	8	70.11	8	0	19.5	16.7
2b	70.0	4	9	58.47	6	3	16.9	16.9
3a	87.5	4	28	51.23	20	8	49.9	26.9
3b	87.5	4	41	58.80	25	16	42.4	25.0
4a	105.0	4	30	70.20	14	16	45.0	24.0
4b	105.0	4	22	67.41	11	11	26.0	19.3
5a	122.5	4	30	63.56	16	14	34.0	21.2
5b	122.5	4	30	64.57	10	20	47.7	16.2

TABLE 11

Showing the effect of soil and sub-soil on Tiniaong, a variety of upland rice

CAN NO.	MEDIA	NO. OF PLANTS AT MATURITY	TOTAL NO. OF CULMS PER CAN	AV. HEIGHT OF CULMS PER PLANT	TOTAL WEIGHT OF STRAW PER CAN	TOTAL WEIGHT OF GRAINS PER CAN
				cm.	*grams*	*grams*
28a	Soil alone	6	15	69.10	123.20	10.6
28b	Soil alone	6	17	70.56	135.90	12.1
29a	Sub-soil alone	6	9	51.87	4.20	3.1
29b	Sub-soil alone	6	7	58.40	4.70	2.8
30a	Soil and sub-soil 50–50	6	12	66.88	10.60	5.0
30b	Soil and sub-soil 50–50	6	10	62.63	5.10	5.7

DISCUSSION OF RESULTS

Kainit, applied singly, reduced the production of grain of lowland rice ten times and of upland rice four times that of the control. In combination with superphosphate, dried blood, and lime, kainit was ineffective. It is shown in tables 1 and 3 that the application of kainit in greater concentrations tended to reduce the yield of grain of rice. This effect was more marked on the lowland rice than on the upland. In general, kainit proved toxic to both lowland and upland rice.

Superphosphate, applied singly, trebled the production of grain of lowland rice, but only slightly increased the production of upland rice (see tables 2 and 4). In combination with kainit, dried blood, and lime, superphosphate increased the production of rice grain of both lowland and upland rice. The increases, however, were not proportional to the concentrations of superphosphate applied.

Lime, applied singly, increased the production of lowland rice four times, but reduced that of upland rice slightly. An unreported experiment conducted in the same season under the direction of the writer on plots 50 square meters in area to determine the effect of lime on upland rice gave the following results:

Plot No.	*Rate of application per hectare*	*Estimated yield of grain per hectare*
	kgm.	*kgm.*
1.....	1000	760
2.....	1500	700
3.....	check	780
4.....	2000	600
5.....	2500	380
6.....	check	776

These data show that, apparently, liming upland rice reduced the yield of grain. It is very probable that the application of lime was followed by the loss of nitrogen in the form of ammonia. In water-saturated soil, ammonia may be liberated following the application of lime, but it may be fixed and not lost due to the saturation. In combination with kainit, superphosphate, and dried blood, the effect of lime on the production of lowland and upland rice was about the same as that of superphosphate.

Applied singly, dried blood increased the production of lowland rice 17 times, and that of upland rice four times; the yield of straw of both lowland and upland rice was also much increased. In combination with kainit, superphosphate, and lime, it was found that, in general, the yield of straw and grain of both upland and lowland rice was proportional to the amounts of dried blood applied. This was especially noted with upland rice.

The results of the experiments given in tables 5 and 6 in which dried blood was applied in different amounts alone and in combination with kainit,

superphosphate, and lime, show conclusively a very strong correlation between the amounts of dried blood applied and the yield of straw and grain.

Sodium nitrate applied alone to water-saturated soil proved toxic to rice. Cultures Nos. 22a and 22b, table 3 were planted with rice seedlings six times at intervals of about five days. At the sixth planting, one plant in each culture grew. Both plants produced some straw, but failed to produce grain. It is a known fact that nitrate (NO_3), for lack of proper aëration is converted into nitrites (NO_2), which is poisonous, and which undoubtedly is the cause of the toxicity. When applied to soil that was not saturated with water, as was the case with cultures Nos. 22a and 22b, table 4, sodium nitrate was very effective in increasing the yield of grain and straw of rice.

Tables 9 and 10 show the results of two sets of experiments; in the first set, sodium nitrate was applied in combination with kainit, superphosphate, and lime; in the second set, it was applied alone. Varying amounts of the salt in both cases were applied. Increases of yield of grain and straw were obtained in the single application and in the applications with kainit, superphosphate, and lime. There was, however, no definite correlations between amounts of sodium nitrate applied and yield of straw and grain. Sodium nitrate was more effective when applied with other fertilizers than when it was applied alone.

In this experiment, it was found, as established by other investigators, that ammonium sulfate was effective as fertilizer for rice, but, (*a*) that the effect of ammonium sulfate was influenced by the saturation of the soil; (*b*) that the optimum application in water-saturated soil is below the optimum application in moist soil; (*c*) that the optimum application is influenced by the season; and (*d*) that beyond a certain maximum, ammonium sulfate is toxic to both upland and lowland rice.

The set of experiments recorded in table 3 shows that the optimum application was 35 grams to 20 kilograms of soil. When the applications were increased, the plants produced straw, but, in general, failed to produce grain. The soil in this series was tested for acidity, according to the official method of testing for acid in the soil, and it was found that the amounts of acid varied directly with the amounts of ammonium sulfate applied. The results in the acidity tests point to the possibility of the formation of sulfuric acid from the ammonium sulfate.

The set of experiments given in table 4 shows that the best application of ammonium sulfate was 70 grams to 20 kilograms of soil. This is an upland series. The optimum application in this series is twice that of the lowland series. It is also shown that the yield of grain decreased as the amounts of ammonium sulfate application was increased.

Late in the season, two more sets of ammonium sulfate experiments were started. The results are shown in tables 7 and 8. In one set, am-

monium sulfate was applied in combination with kainit, superphosphate, and lime; in the second set, it was applied alone. Ammonium sulfate was applied in varying amounts in each set. The optimum amount, when this salt was applied with other fertilizers, was 17.5 grams to 20 kilograms of soil, but when applied singly, it was 8.75 grams. In these two series of experiments it is obvious that the other fertilizers used with ammonium sulfate were practically ineffective.

In table 11 is shown a side line experiment to determine the effect of soil and sub-soil on the production of rice. The table shows conclusively that the "fat of the land" is in the soil and not in the sub-soil.

CONCLUSIONS

Kainit, applied singly or in combination with other fertilizers, is not only ineffective, but toxic to rice.

Superphosphate, applied singly or in combination with other fertilizers, increased the production of rice only slightly. It is a more effective fertilizer for lowland than for upland rice.

Lime increased the production of lowland rice, but decreased the production of upland rice. In combination with kainit, superphosphate, and dried blood, its effect in increasing the production of rice was the same as the effect of superphosphate.

Dried blood increased the yield of grain and straw of rice very greatly. Applied singly, or in combination with kainit, superphosphate, and lime, there was found a decidedly strong correlation between the amounts of dried blood applied and the yield of straw and grain.

Sodium nitrate was toxic to lowland rice. It proved an effective fertilizer for upland rice, whether applied singly or in combination with other fertilizers.

Ammonium sulfate was effective in increasing the yield of straw and grain of rice, both lowland and upland. Its effect was influenced by the water content of the soil and by the season. Beyond a maximum application, ammonium sulfate is toxic to both lowland and upland rices.

Dried blood was a more effective nitrogenous fertilizer than either ammonium sulfate or sodium nitrate.

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CAECAL DIVERTICULUM IN A TURKEY[1]

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WITH TWO TEXT FIGURES

So far as the writer has been able to refer to literature on diseases of poultry, not a single case of *Caecal diverticulum* has been reported. The object of this paper is to record one such case in a turkey.

CLINICAL RECORD

On November 3, 1925, a black female turkey was brought to the Clinic of the College of Veterinary Science with the suspicion that the fowl was affected with "limberneck". Upon clinical examination, the following symptoms were observed.

Fig. 1.—A turkey showing inability to stand up due to autointoxication resulting from coprostasis.

[1]Experiment Station contribution No. 361. Received for publication January 8, 1926.

The fowl could not stand up and if made to do so, it was unable to keep itself steady on its legs (see fig. 1); the head was thrown backward and fell over. If the neck was extended and the head brought forward, the fowl fell on its breast. There was not complete loss of control of the neck muscles as is found in cases of "limberneck". The beak was open, pupils dilated and rapid respiration was present. The crop was empty as the bird refused to eat; the excreta was fluid and contained a great amount of urates. There was no marked elevation of the body temperature. The digits were flexed and when extended with the hand, they returned to this flexed position.

Four blood smears were made from the axillary vein. These were dried, stained with Wright's stain and examined microscopically. This examination revealed marked eosinophilia.

The diagnosis was reserved. Five drops of 0.5 per cent sulfuric acid solution in a little water with a medicine dropper was administered to the bird. Forced feeding with rice gruel was also given.

The following day, the fowl appeared better, the respiration being easier and the anxious look of the previous day was no longer noticeable. The bird was unable to stand up however, the digits being kept flexed and the body was weak. Three mils of 5 per cent phenol solution was injected subcutaneously on the right side. Forced feeding continued.

On November 5, 1925, the bird was very weak and was found in a peculiar position, resting partly on its breast and partly on its right side with the left leg advanced forward and the right one extended backward. The digits were flexed; the peculiar position of the legs could not be altered by manipulation with the hands. The excreta assumed a semi-solid consistency and were green in color.

The fowl died on the fourth day after it was brought to the Veterinary Hospital and a post-mortem examination was performed the same day.

AUTOPSY FINDINGS

External examination

Rigor mortis is present all over the carcass; the fleshy portion is cyanotic, while the wattles are pale-red in color. The beak is open; there is a yellowish fluid discharge present at the commissures of the mouth. The mucous membrane of the pharynx is cyanotic. The vent is soiled with dried excreta. Weight is 2.1 kilograms.

Internal examination

The subcutis is pale and dry. The crop is partially filled with grass, coagulated milk, and a paste-like, slimy, white liquid; its external coat is congested and the mucosa is pale. The blood vessels of the omentum are injected. Serosa of the proventriculus is reddened and its content is a slimy, greyish-white fluid. The follicular glands are prominent. The fat around the gizzard is scanty; its muscular wall is atrophied and its con-

tent is composed of pebbles, pieces of grass, and unhulled rice. The odor of the contents is that of fermented food. The epithelium is adherent and black in color. The mucosa of the small intestines is reddened; that of the duodenum and ileum show few petechiae. The content is semi-fluid and yellowish and the mesenteric blood vessels are injected. The right caecum presents a large oval diverticulum at its fundus, the size of a hen's egg. This diverticulum is located in the pelvic region to the right of the cloaca and adjacent to the anal opening with its long diameter at right angle with the axis of the body. Its external coat is the same in color as the intestinal wall, being covered with serosa. Upon opening this diverticulum, it was found to be connected with the lumen of the right caecum through an opening about one centimeter in diameter. A small constriction is present one

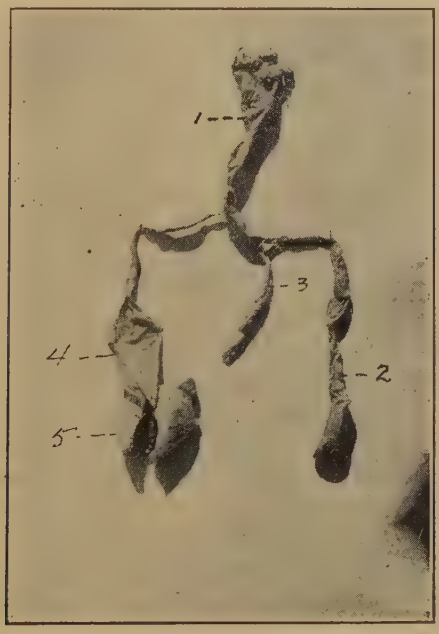

Fig. 2.—(1) cloaca, (2) left caecum, (3) ileum, (4) right caecum, (5) diverticulum.

centimeter away from its right pole. This is adherent to the right ischium. The longer diameter measures eight centimeters, while its shorter diameter is six centimeters. When filled with water, it contains about 40 mils. The wall is the same in thickness as that of the caecum and the coats of its parietal wall are continuous with those of the caecum. It is, however, lined inside by a tough, brownish coat of inspisated feces. (See fig. 2.) The cavity of the diverticulum is filled with thick, stinking, brownish feces.

The spleen is smaller than normal; it weighs 0.5 gram; is dark-blue in color and the Malpighian corpuscles are prominent. The kidneys are

swollen and reddened. The liver is dark-chocolate-brown in color, except at the margin where it is paler and petechiated; it weighs 64 grams; on section, the incision edges bulge out, the cut surfaces are convex, juicy, and the central veins are engorged with dark coagulated blood. The gall-bladder contains greenish-yellow bile. The ovaries are reddened; presence of immature ova ranging in size from a sago grain to that of a pea, and the blood vessels of the oviduct are injected.

The pleural cavity is glistening and moist; there is an extensive adhesion between the left thoracic wall and the left lung. The heart is cone-shaped; there is present at the apex a small area of necrosis the size of a pin head; the coronary blood vessels are prominent and surrounded by yellow fat; the auricles are distended with dark coagula; the ventricles contain little blood. The heart muscle has a cooked appearance. The left lung is closely adherent to the thoracic wall by fibrinous exudate; one half of its area is hepatized, grey in color, and pieces of it placed in water do not float. There are two areas of necrosis the size of a grain of corn present in this lobe. The right lung is pink-red in color and is crepitant. The trachea and bronchi are congested.

The bone-marrow of the femur is pale-red. The blood vessels at the base of the brain are engorged with blood.

ANATOMICO-PATHOLOGICAL DIAGNOSIS

1. Atrophy of the gizzard.
2. Hemorrhagic enteritis (mild).
3. Cloudy swelling of the solid organs.
4. Fibrinous pleuritis.
5. Fibrino-purulent pneumonia.
6. Caecal diverticulum, adquired.
7. Coprostasis.

EPICRISIS

1. Primary cause of death is auto-intoxication resulting from coprostatis due to a *diverticulum* of the right caecum.

2. Secondary cause of death is purulent pneumonia.

The diverticulum was probably caused by the adhesion of the fundus of the caecum to the ischium as a result of local peritonitis. This adhesion must have given rise to retention of fecal material and gas formation in the right caecum with consequent weakening and permanent distention of the distal portion of this organ resulting in the formation of the adquired diverticulum.

COMPARISON OF YIELDS OF THIRD AND FOURTH GENERATIONS TOBACCO HYBRIDS WITH YIELDS OF PARENT VARIETIES[1]

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The object of this paper is to analyze the yield data obtained from the third and fourth generations hybrids and their parents in 1923 and 1924.

MATERIALS AND METHODS

The names of both parents and hybrids, herein reported, are given in table 1. The male parents are all imported, and the females are all native. There were 4956 hybrids and 2756 plants of parent varieties studied for this work.

TABLE 1

Varieties used

HYBRIDS NO.	MALE PARENT	COLLEGE NUMBER	GENERATION	FEMALE PARENT	COLLEGE NUMBER	GENERATION
1	Improved Gold Leaf	7808	F_4	Repollo	9976	F_3
2	Improved Gold Leaf	7808	F_4	San Antonio	17099	F_2
3	Connecticut Havana	4828	F_4	San Juan Batec	17227	F_2
4	Connecticut Havana	4828	F_4	Romero	7891	F_2
5	Improved Gold Leaf	7808	F_4	Romero	7891	F_2
6	Connecticut Havana	4828	F_4	Repollo	9976	F_3
7	Connecticut Havana	4828	F_4	Dammao Broad Leaf	9975	F_3

The native varieties were obtained from Isabela Province in 1918, with the exception of San Antonio which was introduced into the College of Agriculture in 1919 from a farm in the vicinity of Los Baños, Laguna. Connecticut Havana was introduced from the United States Department of Agriculture in 1918 and Improved Gold Leaf is a variety received from Richmond, Virginia in 1917.

Before going into the detailed discussion of the results herein presented, it may be well to take a general survey of the hybridization work carried on at the College of Agriculture in 1920 with the Plant Breeding Division, Agronomy Department. This work was begun in that year by making seven distinct crosses between the native and imported varieties then under

[1]Experiment Station contribution No. 362. Received for publication, March 16, 1926.

culture. The method used was that which is generally followed in tobacco hybridization.

The first crop grown from the first generation hybrid and their parents was produced in 1921. In the first generation, all the hybrids gave higher yields than their respective parents. The most vigorous of the seven hybrids with their corresponding parents were selected for further testing. The seeds from the best plants were sown in 1922. From this seeding, duplicate plantings on a uniform piece of land were made in 1923 and 1924 and the yields determined. The results from the two years' harvests, so far as the general yields obtained are concerned, are encouraging. There was a general increase in the total yields of the hybrids over their parents during the two years covered by this work.

The comparison of the yield data obtained from the hybrids and their parents can best be made by analyzing the results in detail.

In comparing the yields of the hybrids with that of their respective parents, Bessel's formula of the probable error of the mean was used. This formula may be given as follows: P. E_m (probable error of the mean of several items) is equal to $\pm 0.6745 \sqrt{\frac{\leqslant d^2}{n(n-1)}}$ in which d refers to the deviation of the different items from their means, n, the number of items and $\leqslant$, the sum of d^2.

The calculated yield per hectare of each of the hybrids and parents as obtained from the different plots is given in table 2. The deviation, d, of each yield item from the mean was determined and squared and the squares added, as shown in table 2.

TABLE 2

HYBRIDS	CALCULATED YIELD PER HECTARE	DEVIATION FROM THE MEAN	DEVIATION^2 d^2
	quintals [a]	*quintals*	*quintals*
Hybrid No. 1 F_3, F_4	10.94	—2.88	8.2944
Hybrid No. 2 F_3, F_4	13.98	+0.16	0.0256
Hybrid No. 3 F_3, F_4	14.63	+0.81	0.6561
Hybrid No. 4 F_3, F_4	15.03	+1.21	1.4641
Hybrid No. 5 F_3, F_4	13.58	—0.24	0.0576
Hybrid No. 6 F_3, F_4	15.48	+1.66	2.7556
Hybrid No. 7 F_3, F_4	13.11	—0.71	0.5041
	Total 96.75		13.7575
	Mean 13.82		
Parents			
Romero, F_5	11.36	+1.29	1.6641
Dammao Broad Leaf, F_6	10.71	+0.64	0.4096
Repollo, F_6	7.23	—2.84	8.0656
San Antonio, F_5	6.79	—3.28	10.7584
San Juan Batec, F_5	14.17	+4.10	16.8100
Connecticut Havana, F_7	11.77	+1.70	2.8900
Improved Gold Leaf, F_7	8.46	—1.61	2.5921
	Total 70.49		43.1898
	Mean 10.07		

[a] A quintal is equivalent to 46 kilograms.

The probable error of the mean yield of the seven hybrids was found by applying the formula, thus: P. E_m is equal to $\pm 0.6745)\sqrt{\frac{13.7575}{7\ (7-1)}}$ $= \pm 0.38$. Therefore, the yield per hectare of the hybrids in question is 13.82 $\pm$0.38 quintals. The probable error of the mean yield (10.07) of the seven parents was determined in the same manner, and found to be $\pm$0.68. In other words, the yield per hectare of the parents used in this experiment is 10.07 $\pm$0.68 quintals.

The probable error of the difference of the mean yield of the hybrids and that of their parents was determined. The formula for the probable error of the difference of the two means, the probable errors of which are known, is $\pm\sqrt{A^2+B^2}$ in which A represents the probable error of the mean yield of the hybrids and B of the parents. Applying this formula to the problem in question, the probable error of the difference between the two mean yields of the hybrids and parents was found, thus: $\pm\sqrt{(0.38)^2+(0.68)^2} = \pm 0.78$.

Since the yields per hectare of the hybrids and that of the parent plants are 13.82$\pm$0.38 and 10.07$\pm$0.68 quintals respectively, then the difference in yield between the two and its probable error, as determined, is 3.75$\pm$0.78 quintals per hectare.

According to the usual way of interpretation of the experimental results, the difference in yield may be taken to be so significant as to warrant the conclusions reached.

CO-OPERATIVE TESTS BY FARMERS

It is the aim of the Department of Agronomy, College of Agriculture, to distribute seeds of these more productive tobacco hybrids among the tobacco growers of the Philippines, who may care to test them.

The plan followed in this distribution was to place the hybrid seeds in the hands of careful tobacco farmers who are willing to give them a careful test in comparison with some standard varieties they have been accustomed to grow. The growers are required to report to the Agronomy Department, College of Agriculture, Los Baños, Philippines, the data concerning the yields of the new hybrid seeds furnished them. The aim in all cases was to make the co-operator as little extra trouble as is consistent with obtaining the desired data. Through these co-operative plantings, the Agronomy Department can study the adaptability of the new hybrid varieties to the various soil conditions and cultural requirements obtaining in the different tobacco growing provinces of the Philippines. And the growers can have a much more accurate idea of the relative merits of the new hybrid varieties they are testing.

There were several farmers, who in the past tested one or more of the new varieties. Because of the limited area planted to the hybrid seeds and the failure of some of the farmers who requested the seeds to submit

the report of their results, comparative yields of the hybrids obtained by co-operative growers cannot be included in this present paper.

CONCLUSIONS

The results thus far obtained in this experiment seem, fairly, to justify the following inferences:

1. The yield per hectare of hybrids Nos. 1-7 as a group in the third and fourth generations was significantly higher than that of their respective parents also taken as a group.

2. The difference in yield may be considered as due to the hereditary differences of the hybrid and parent plants.

3. Higher yield in tobacco can be obtained by hybridization if followed by careful selection throughout all the work with the hybrid progeny.

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BACTERIAL WILT OF MARIGOLD, OR AMARILLA[1]

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Of the Department of Plant Pathology

WITH THREE FIGURES

OCCURRENCE AND SYMPTOMS OF THE DISEASE

A bacterial wilt of marigold, or amarilla (*Tagetes erecta* L.) was collected from the flower beds of the lower nursery of the College of Agriculture at Los Baños, Laguna, Philippine Islands, in October, 1925. At that time of the year the disease was common and caused wilting of many of the plants. Wilted amarilla collected on various occasions and examined under the microscope showed an abundance of bacteria in the xylem tubes of the vascular bundles. Isolation of the organism at different times invariably gave pure cultures of one type of bacteria. Pure culture of the organism used in inoculation experiments proved that the bacteria in the bundles are responsible for the wilting of the plants.

Amarilla wilt is characterized by the wilting of the foliage. The general symptoms are much like those described for the bacterial wilt of various species of plants due to *Bacterium solanacearum* E. F. Smith. At first there is no marked discoloration of the leaves. Sometimes wilting of leaves is very conspicuous on one side of the plant while the leaves on the other side are unaffected. In a majority of instances the diseased plants do not recover. They die within three to five days after the first symptom of the wilt appears. In some cases, the disease progresses very slowly and causes the plants to become stunted, but eventually the plant is killed.

CAUSAL ORGANISM

The cells of the bacteria causing marigold wilt are short rods with rounded ends. The cells are shorter and more plump when they are in the host tissue than when they are grown in nutrient broth. In the host tissue the rods measure from $0.5\text{-}0.6 \times 0.8\text{-}1.2\,\mu$ and in pure culture the size ranges from $0.5\text{-}0.7 \times 0.8\text{-}1.8\,\mu$. In broth cultures the rods may occur singly, in pairs, or in chains of as many as five cells. The bacteria are motile, aerobic, non-spore and non-capsule former. The organism is readily

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[2] The writer is indebted to Dr. G. O. Ocfemia, Acting Head of the Department of Plant Pathology, for reading the manuscript.

Photographs in this article by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, P. I.

stained with aqueous solutions of the common anilin dyes. The bacterium is Gram negative. The staining reactions and morphological characters are very similar to those which have been described by Smith (1914) for *Bacterium solanacearum* E. F. Smith. Smith (1914) and Bryan (1915) give $0.5\times1.5\mu$ and $0.6\times0.8\text{-}1.3\mu$, respectively for the size of the cells of *Bacterium solanacearum* in pure cultures. The figures of these authors are slightly smaller than those of the amarilla bacterium, but the writer believes that the difference is not of sufficient weight to separate the Philippine form from the species of Smith.

Fig. 1.—Amarilla artificially inoculated with the amarilla strain of *Bact. solanacearum*. Photographed seven days after inoculation. The arrow head indicates the site of inoculation.

Fig. 2.—A young tomato plant artificially inoculated with the amarilla strain of *Bact. solanacearum*. Photographed six days after inoculation. The arrow head indicates the site of inoculation.

Like *Bacterium solanacearum* E. F. Smith the amarilla organism can be grown readily upon common laboratory media, preferably if these are slightly acid. For comparison, a freshly isolated organism from wilted tomato was used. Both the amarilla strain and tomato strain were grown on the same kind of culture media. The cultural characters of the amarilla organism in all cases conformed with those of the tomato *Bact. solanacearum*. The colonies developed after 24 hours on poured plate potato agar. They

are small, round, convex, smooth and dirty white, becoming chocolate or light brown in color after a week.

Buried colonies are ellipsoid to fusiform. On acid-agar slant the growth is slow to moderate, filiform, dirty white, smooth, wet, shining, and with age become thin and light to dark brown. On steamed potato, the growth is moderate, dirty white, glistening wet, and brown to dark-smoke brown after a week old. In broth it produces uniform clouding, with thin fellicles which are readily disintegrated when disturbed. A moderate amount of sediment is formed. The solution becomes clear brown when a week or more old. Milk is cleared and no curdling is produced. In various sugar bouillons neither acid nor gas is produced. No growth in Cohn's and Fermi's solutions was noted although a very slight clouding was produced in Uschinsky's solution.

The pathogenicity of the organism was proved by using pure culture of the tomato *Bacterium solanacearum* and the amarilla wilt organism. Parallel inoculations of the amarilla and tomato bacteria were conducted. Infection was secured in inoculation of various known hosts of the bacterial-wilt organism, *Bact. solanacearum* E. F. Smith. Infection was produced through needle pricks on young and tender stems of the plants (figures 1, 2, and 3).

Wilting occurred from three to eight days after inoculation, depending on the kind of tissue and the site of inoculation.

In tender tissues, infection started earlier than on more woody tissues. In some cases infection failed to develop on hard and woody stems. Inoculations were made on tomato (*Lycopersicum esculentum* Mill.), potato (*Solanum tuberosum* L.), tobacco, castor bean (*Ricinus communis* L.), amarilla, pepper (*Capsicum annuum* L.), and egg-plant (*Solanum melongena* L.). Of the hosts inoculated, the amarilla bacterium was capable of infecting tomato, potato, tobacco, and castor bean. The organism did not produce the disease on pepper and egg-plant. The tomato strain, on the other hand, infected all of these plants, although the infection pro-

Fig. 3.—A young tobacco plant artificially inoculated with the amarilla strain of *Bact. solanacearum*. Photograph six days after inoculation. The arrow head indicates the site of inoculation.

duced on pepper and eggplant was slight. The eggplant recovered. The organisms were recovered in re-isolation from inoculated plants. The difference in infective power of the organisms is probably due to differences of hosts and that woody tissues are more resistant to infection than tender tissues. Another factor which may be responsible for the varied ability of the organism to cause infection is the difference in their virulence. Bryan (1915) and Smith (1920) state that the virulence of the bacterial wilt organism decreases considerably if the cultures are kept long without giving them a chance to pass through the hosts.

The characters shown by the amarilla bacterium in cultural studies, in morphological characters, in biological relations to different known hosts of *Bact. solanacearum* seem to show that it is identical with the *Bact. solanacearum* E. F. Smith.

SUMMARY

Bacterial wilt of amarilla was first noted in the nursery of the College of Agriculture, Los Baños, Philippine Islands, in October, 1925. The disease is characterized by wilting without any apparent marked discoloration of the foliage. Microscopic examination and isolation of the parasite from the diseased plants showed that bacteria are constantly associated with the diseased plants. Experimental infections readily proved that the bacterium is responsible for the disease.

The cultural, morphological, and biological characters of the amarilla-wilt organism compares favorably with that of *Bact. solanacearum* E. F. Smith.

The amarilla strain of *Bact. solanacearum* is capable of infecting potato, tomato, tobacco, and castor bean. These plants have been reported as susceptible to attacks of *Bact. solanacearum.* The tomato strain of *Bact. solanacearum* is also capable of infecting amarilla.

The writer believes that the bacterium causing the wilt of amarilla is identical with *Bact. solanacearum.*

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LEAF CRYSTALS IN FICUS AND OTHER GENERA[1]

HILARIO M. TURGANO

The object of this work was the study of the crystals occurring in various plants on Mount Maquiling, with special reference to those plants containing stinging crystals, or raphides.

It was also the intention of the writer to find an answer to each of the following questions:

(*a*) Do the results of this investigation correlate with those in other countries?

(*b*) Are the crystals sought in this work common in the leaves and fruits of local species?

(*c*) Do crystals of one kind occur with crystals of another kind in the same organ of the same plant?

(*e*) What correlation is there between the kinds and forms of crystals and their functions?

The work was begun early in June, 1923, and continued until February, 1924. The specimens used in this work were collected from the College grounds where a part of the investigation work was carried on. The greater part of the work was done in the Plant Physiology Laboratory, College of Agriculture, Los Baños, Philippine Islands.

MATERIALS AND METHODS

Leaves of several plants, belonging to Araceæ, Moraceæ, and Urticaceæ, and fruits of cabo negro (*Arenga pinnata* Wurmb) Merr.), fish tail palm (*Caryota cumingii* Lodd.), and buri palm (*Corypha elata* Roxb.) were used as the specimens for this work. The work may be divided into two parts; namely, (1) microscopic examination; and (2) irritating, or stinging-test examination.

Microscopic examination

To examine microscopically, means the examination of the different specimens for the detection and identification of their crystal content; also, the sketching of a typical representative of each of the different forms of crystals found in the different specimens. Surface and cross sections were prepared by the free hand method of cutting sections from different portions of a number of specimens of the same kind. These sections were directly mounted, usually four to five cuts from each of the two kinds of section,

[1] Thesis presented for graduation, 1924, from the College of Agriculture, No. 223; Experiment Station contribution No. 364. Prepared in the Department of Plant Physiology under the direction of Professor D. A. Herbert.

on separate slides provided with cover glasses. They were then examined under the microscope, noting the presence or absence of crystals, which are recognized by their white glistening appearance. These crystals were then treated with two or three drops of HCL (concentrate) dropped from a medicine dropper; at the same time the reactions taking place between the acid and the supposed crystals were observed. For this work the writer based his observations upon the common experience of different authors, that crystals of calcium carbonate and calcium oxalate are readily soluble in any of the mineral acids, the former being more soluble and producing effervescence, or bubbles of carbon dioxide; but those of silica are not affected in any way.

Using freshly cut sections each time, the above procedure was repeated until a sufficiently clear view of the different forms of crystals found in that particular specimen was obtained. A sketch was then made of each of the forms, after which a final observation was made of their real nature and composition. Success in this work depends upon one's practice and experience in the preparation of sections (for sections too thick or too thin are objectionable) and also upon cleanliness and tidiness with apparatus.

Irritating, or stinging-test examination

Several portions of each of the specimens (leaves or fruits) were crushed and the juice with the crystals was pressed out and applied to the skin inside the elbow. In the case of those plants under Urticaceae, which possess stinging hairs, both the upper and the lower epidermis of the leaves were carefully stripped off with a sharp knife before the leaves were applied to the skin. The effect of this application was observed for 20–30 minutes, then determined, approximately, whether the effect was irritating, very irritating, or no sensation. To relieve the skin from the pain or irritation produced, ammonium hydroxide was applied to the portion affected. Ammonium hydroxide is an enzyme poison and hence has the property of retarding or destroying the irritating property of the substance.

RESULTS

The results were arranged in tabulated form and are presented in tables 1, 2, and 3.

DISCUSSION OF RESULTS

Occurrence and distribution of mineral deposits in the plants examined

The results presented in this paper seem to show that all the plants examined, except the buri palm, contain deposits of calcium oxalate, calcium carbonate, or silica. (With the buri palm only a limited supply of the fruit was available.) Most of the plants contain crystals of calcium oxalate while only a few contain calcium carbonate and silica. Workers on

the subject seem to agree that calcium oxalate being a by-product in the synthesis of protein, a very important process in actively growing plants, must necessarily be developed in greater amount and in a greater number of plants than either calcium carbonate or silica. Concerning these latter two compounds, Schimper regards calcium carbonate as a secondary product from other compounds of calcium; according to Ganong, this compound together with silica may be one of those useless substances which are accidentally absorbed by the roots along with the useful and which have formed or crystallized in cells or cell-walls as waste products in plants. These two authors make it clear that the sources of the two compounds under discussion are not continuous or dependable; hence the formation of these compounds in plants is not so common as that of calcium oxalate.

The forms or types of mineral deposits detected and identified

At this point it should be mentioned that calcium oxalate, as detected and identified in this work, occurs in two forms only—raphides and rosette aggregates. Both of these forms seem to be closely associated although in the plants examined they do not occur together in the same cells. The raphides or raphide-bundles are generally found along a layer of the parenchyma cells or even in the palisade cells, while the rosette aggregates are found exclusively in the epidermal cells. In the case of the fruits of *Arenga pinnata* (Wurmb) Merr. and *Caryota cumingii* Lodd., the raphides are found only in a layer of cells on the inner side of the endocarp. The absence of the other form in these two plants may mean that in the fruit is not a better place for its development than in the epidermal cells of leaves.

The raphides are composed of needle-shaped crystals of calcium oxalate, usually of equal length and arranged parallel to one another in a tightly packed bundle, or raphide-bundle. This raphide-bundle, in turn, is contained in a tabular thin-walled cell, called the raphide-sac, which varies more or less in size or in shape with the different plants in which it occurs.

Deposits of calcium carbonate are found also to occur in two forms. One of these forms is called the cystolith, which is described by Haberlandt and Kraemer as resembling a cluster of grapes or a mulberry fruit suspended by its stalk from its outer wall. The differences between them seem to reveal a case similar to that shown by the differences noted in the raphide-sacs previously discussed. For instance, the more lengthened cystolith with bulging body protuberances is common in the thicker and spongy leaves of *Ficus elastica* Roxb. and *F. indica* Linn., while the more rounded one with compressed body protuberances is found in the thin compact-tissued leaves of *Ficus nota* (Blanco) Merr., *F. pseudopalma* Blanco, *F. ulmifolia* Lam., and *Streblus asper* Lour.

The other form of this compound usually occurs as an intercalation or as an incrustation in the cell wall. It sometimes occurs with silica in the same cell wall, hence the difficulty of identifying them. However, with

the aid of any of the mineral acids, preferably hydrochloric acid, the calcium carbonate can be identified by its ready solubility and the evolution of bubbles of carbon dioxide. This form is especially noted in all of the plants listed under Moraceæ.

Silica, in turn, rarely occurs as a cell-content, being usually found as an incrustation in the cell wall in the epidermal cells, spinose hairs, and even the palisade and mesophyll cells of a number of plants. The presence of this form is especially noted in the epidermal cells and spinose hairs of *Ficus nota* (Blanco) Merr., *F. pseudopalma* Blanco, *F. ulmifolia* Lour. and *Streblus asper* Lour. and also in the stinging hairs of those plants listed under Urticaceæ. The rough and sandy surfaces of the leaves of *F. ulmifolia*, *F. pseudopalma* and *Streblus asper* indicate the presence of abundant silica in these plants.

The functions of the different forms of mineral deposits in plants

The common occurrence of the different forms of mineral deposits in the leaves and fruits of plants seems to be well shown by the results of this investigation. It is known that these mineral deposits perform two important functions in plants, as (*a*) excretory system, and (*b*) as protection against noxious animals and against the action of other ecological factors. There seems to be no better parts or organs of plants in which these functions can be freely and advantageously performed than in the leaves, fruits, and barks. According to Ganong, such mineral deposits are usually regarded as the waste matter in plants which, in the absence of a regularly functioning excretory system, must necessarily be stored up in out-of-the-way places, though ultimately they may be partially removed by the fall of the leaves, fruits, and barks. Furthermore, these organs are in such a responsible position for the proper and normal development of the other parts of the plants that it is but natural that they should be well protected in some way. Hence, the common occurrence of mineral deposits in the three organs, especially in the leaves and fruits, for their free and advantageous performance of their important functions.

The two functions, referred to above, may be clearly noted in the plants investigated. But it is necessary to state that all the mineral deposits found in plants are unquestionably regarded as waste matter. And their storage in out-of-the-way places only ultimately to be partially removed by the fall of leaves, fruits, and barks, is no doubt a sign that mineral deposits in plants do actually provide an excretory system.

The other function, protection against noxious animals and against the action of other ecological agencies, may be attributed to the deposits of calcium oxalate and calcium carbonate-silica, respectively.

Protection against noxious animals by the deposits of calcium oxalate. The list of plants, in tables 1 and 2, show that those plants containing crystals of calcium oxalate cause skin irritation, while those of calcium carbo-

nate do not. The irritation is not due to the stinging hairs or any mechanical injury done by outside protuberances of the leaves or fruits of the plants, for they are perfectly glabrous, or they were made so by stripping off carefully their epidermis to remove their stinging hairs, as in the case of the plants under Urticaceæ. Yet, when crushed portions of the leaves or fruits of the plants containing calcium oxalate are applied to the most sensitive part of the skin, they cause an annoying prickling or irritation, varying of course in degree with the different plants. From observation, the writer of this paper concluded that the irritation he experienced was no doubt associated with the needle-shaped crystals of calcium oxalate. But it can not be due entirely to these structures, for according to Herbert[2] the needle-shaped crystals are not the sole cause of irritation, but are important to the production of the full amount of irritation by preparing the way for the entrance of certain substances associated with them. He further states that these substances vary with the kinds of plants. For instance, he reports that in *Laportea* and *Urtica* the irritation is due to formic acid, while in *Arenga pinnata* (Wurmb) Merr. and *Amorphophallus campanulatus* (Roxb.) Blume it is due to a proteolytic enzyme.

The degree of irritation which varies with the kinds of plants, seems to depend upon the number of the raphides and the amount of enzyme. For instance, the fruits of *Arenga pinnata* (Wurmb) Merr. and *Caryota cumingii* Lodd. contain the most numerous raphides, or stinging crystals and have also been shown to be rich in proteolytic enzymes, hence they cause a greater amount of irritation than any of the other plants listed as causing skin irritation. On the other hand, the leaves of *Anthurium obtusilobium*, *Cyrtosperma merkusii* Schott., *Homalomena philippinensis* Engl. and *Monstera deliciosa* Liébm. have few stinging crystals, or raphides, consequently have very little effect or none at all on the skin, because the initial puncturing of the skin does not take place. A number, however, contain the same amount of crystals but do not cause irritation to the same extent and this is to be attributed to the smaller amount of enzyme present. These differences can well be noted between the *Homalomena philippinensis* Engl. and the *Xathosoma* spp. both of which have practically the same few stinging crystals, but unlike in the degree of their irritating quality, the latter being irritating while the former is not at all. From this instance and from the others listed, it may be concluded that raphides do not always have irritating or stinging properties; it is the presence of other substances, generally associated with them, that causes the full amount of irritation.

Protection against the action of other ecological agencies by the deposits of calcium carbonate and silica. Deposits of calcium carbonate and silica, in turn, do not cause skin irritation as a means of protection to the plants containing them, as do the calcium oxalate deposits, but as a means of protec-

[2] Herbert, D. A. Stinging crystals in plants. Science **60**: 204–205. 1924.

tion they are as important as the latter. Calcium carbonate and silica usually occur together as an incrustation of the cell wall, oftentimes even impregnating the surface of leaves and stems of some plants. Such a deposit is especially noticeable in *Ficus ulmifolia* Lam., *F. pseudopalma* Blanco, *F. nota* (Blanco) Merr., and *Streblus asper* Lour. giving them rigidity and roughness, a property often ignored by destructive animals, especially sucking insects, although it gives the plants protection against the shearing actions of wind and swiftly running water.

SUMMARY OF CONCLUSIONS

Although this work is not claimed to be complete it furnishes some light as regards the kinds and the nature of some of the crystalline earthy matters or deposits commonly found in plants.

1. Crystalline earthy matters or deposits are very common in the leaves and fruits of the plants investigated. This conforms to the findings of other investigators in other countries who claim that such deposits are widely distributed throughout the vegetable kingdom.

2. Calcium oxalate, calcium carbonate, and silica—named in the order of their importance—are very common in the leaves and fruits of the plants examined.

3. Calcium oxalate and calcium carbonate never seem to appear together in the fruit and leaves of the plants examined, but silica is freer in its association with them. Silica is even found with calcium carbonate impregnating the same cell wall or tissue.

4. These three substances may occur in several forms, each of which seems to be especially adapted to certain purposes.

a. The crystals of calcium oxalate, the raphides, cause very marked irritation on the skin.

b. Calcium carbonate and silica are deposited as an incrustation on the cell wall and give the leaves and fruits rigidity and sandy surfaces.

c. The other forms, such as the rosette aggregates of calcium oxalate, the cystoliths of calcium carbonate, etc., do not cause skin irritation as do the raphides, but from their abundance in leaves they appear to be a product of excretion in plants.

TABLE 1

Lists of plants containing crystals in their leaves or fruits

NAMES OF PLANTS	TYPES OF CRYSTALS OF CALCIUM OXALATE IN LEAVES		REACTION OF CRYSTALS WITH HCL	COMMENT ON THE EFFECT OF CRYSTALS UPON THE SKIN
	Raphides	Rosette aggregates		
ARACEAE				
Alocasia macrorrhiza (Linn.) Schott (biga)	Few	Few	All dissolved in hydrochloric acid without effervescence, or bubbles of carbon dioxide (CO_2)	Irritating
Alocasia heterophylla (Presl) Merr. (wild gabi)	Not very many	Few		Irritating
Alocasia portei (Schott) Engl. and Becc. (badiang)	Few	Few		Irritating
Alocasia zebrina C. Kock and Veitch (ornamental)	Many	Few		Very irritating
Amorphophallus campanulatus (Roxb.) Blume (puñgapung)	Many	Few		Very irritating
Anthurium obtusilobium Schott	Few	Few		Not irritating
Caladium bicolor (Ait.) Vent. (ornamental)	Few	Few		Irritating
Colocasia esculentum (Linn.) Schott (taro)	Few	Very few		Slightly irritating
Cyrtosperma merkusii Schott	Few	Few		Not irritating
Dieffenbachia imperialis Linden & André	Many	Many		Very irritating
Dieffenbachia nobilis	Many	Many		Very irritating
Homalomena philippinensis Engl. (tahig)	Few	Very few		Not irritating
Merbelia grandiflora	Many	Few		Irritating
Monstera deliciosa Liebm.	Few	Few		Not irritating
Philodendron gloriosum André	Few	Few		Very slightly irritating
Philodendron quadriangularis	Few	Few		Slightly irritating
Schizmotoglottis latifolia viridis	Few	Very few		Slightly irritating
Rhaphidophora merrilli Engl. (amlong)	Many	Very many		Irritating
Xanthosoma sagittifolium Schott (yautia)	Few	Few		Irritating
Xanthosoma maculatum	Few	Few		Irritating

TABLE 2

Lists of plants containing crystals in their leaves or fruits

NAME OF PLANTS	TYPES OF CRYSTALS OF CALCIUM OXALATE IN LEAVES		REACTION OF CRYSTALS WITH HCL	COMMENT ON THE EFFECT OF THE CRYSTALS UPON THE SKIN
	Raphides (CaC_2O_4)	Cystoliths ($CaCO_3$)		
MORACEAE			All dissolved in hydrochloric acid with bubbles of carbon dioxide (CO_2)	
Ficus elastica Roxb. (India rubber tree)	Few	Not many in leaves		Not irritating
Ficus nota (Blanco) Merr. (tibig)	Few	Many in leaves		Not irritating
Ficus indica Linn. (balete)	Few	Not many		
Ficus pseudopalma Blanco (lamiog)	——	Many in leaves		Not irritating
Ficus ulmifolia Lam. (uplas)	——	Many in leaves		Not irritating
Streblus asper Lour. (alodig)	——	Present in leaves		Not irritating
PALMAE			All dissolved without effervescence, or bubbles of carbon dioxide (CO_2)	
Arenga pinnata (Wurmb) Merr. (cabo negro)	Numerous in fruits			Very irritating
Caryota cumingii Lodd. (taquipan)	Numerous in fruits			Very irritating
Corypha elata Roxb. (buri)	None in fruits			
URTICACEAE				
Fleurya interrupta (Linn.). Gaudich. (lipang-aso)	Fewer in leaves			Slightly irritating
Laportea meyeniana (Walp.) Warb. (lipang calabao)	Few in leaves			Slightly irritating

TABLE 3

Lists of plants containing mineral deposits (amorphous form) in their leaves

NAMES OF PLANTS	MINERAL DEPOSITS OCCURRING AS INCRUSTATIONS IN THE CELL WALLS OF THE LEAVES			REMARKS ON REACTION WITH HCL
	Silica	Calcium carbonate	Both silica and calcium carbonate	
MORACEAE				
Ficus elastica Roxb. (India rubber tree)	——	Present		Incrustation readily soluble with formation of bubbles of carbon dioxide (CO_2)
Ficus indica Linn. (balete)	——	Present		
Ficus nota (Blanco) Merr. (tibig)	Present	Present	Both present	
Ficus pseudopalma Blanco (lamiog)	Present	Present	Both present	Part of incrustations not soluble in the reagent used
Ficus ulmifolia Lam. (uplas)	Present	Present	Both present	
Streblus asper Lour. (alodig)	Present	Present	Both present	
URTICACEAE				
Fleurya interrupta (Linn.) Gaudich. (lipang-aso)	Present			Incrustation insoluble in the reagent used
Laportea meyeniana (Walp.) Warb. (lipang calabao)	Present			

NOTE: "THE STUDENT AND HIS FUTURE"

Extracts from Commencement Address delivered by Doctor B. M. Gonzalez at Junior College of the University of the Philippines at Cebu, March 26.

* * * It is our good fortune that we are of a young country the history of which is yet in the making. There is little to look back to, the path ahead extends to an illimitable horizon.

A country like ours, which is rich in ambition but poor in resources, expects big returns in investments for progress. Knowing what education along well directed lines has done for other countries, ours has gone to the limit to provide a worth while education for its people. * * * Educators tell us that the State's first duty to its citizens is to carry them through the primary grades, and that beyond that its efforts are purely optional. The State has chosen to conduct a public high institution of learning, the University of the Philippines, and has made the financial requirements for entrance into it so low as to open its doors to the most destitute, almost. This is the correct state of affairs, for a country should not lose the services of some of its best men just because they happen to be born poor. It is equally true, however, that this very educational democracy places higher education easily within reach of those who are unable to make good use of it because of inadequate mental equipment. It seems a wise policy not to litter our high institution of learning with such "dead timber" to the exclusion of better raw material so long as facilities cannot be provided for everybody. The most equitable method of apportioning free public instruction, it seems to me, is through the maintenance of adequate standards of scholarship and accomplishments among students, so as to sift those who do not deserve it. As a pertinent corollary, it becomes an obvious duty of the University to provide instruction of the highest possible grade.

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This struggle of man for existence is largely against the forces of nature, but as man learns to subdue and harness nature to his service, the struggle takes on the form of a man to man combat more and more. The codes of civilized man have outlawed or are fast outlawing the direct methods of struggle. Less and less is an individual or a nation allowed to appropriate by means of force what he covets from his neighbor. Yet the struggle is keener than ever, and keener yet will it become as the population keeps on increasing in this world of ours, which remains perennially stationary in size and resources. The struggle has therefore to seek methods more in consonance with our tenets of justice and enlightened ideas. Diligence, alertness, while others are asleep or biding their time, frugality, economy, oppor-

tuneness, perspicacity; these coupled with implicit honesty and a minimum of brute force are the new tools of struggle of civilized man.

It is the function of education to teach our youth to properly use these new tools. Woe to the man who learns his precepts by rote and leaves it at that, for the circumstances in which he learns them will never be quite the same when he faces actual life's problems.

* * * * * * * * * * * *

If education had as its sole object the acquisition of knowledge, I doubt if the world could be long deceived into investing so much of its resources in it. Education must have demonstrated in the past that it is an effective tool with which to conquer new problems and to acquire additional knowledge. Yet to how many is education nothing more than an opportunity to learn empirical formulæ to be used to fit certain occasions. The need of our country, nay, of the world, is vitalized learning, knowledge that will enable one to meet problems of life in whichever form they may choose to take shape. It is education that enables a man to discern the real cause and effect from the apparent and enable one so endowed to anticipate and judge situations with a certain degree of foresight and calmness. It is the method by which a man indirectly inherits the experience of his forefathers. One without an education is thrown so much on his personal experience and native ability, or call it instinct, if you please, in meeting the problems of life.

Somehow a small country, suffering from the lack of accumulated experience of a vast population to draw from is at a greater disadvantage under the present methods of struggle in our civilized world than it ever was under the more direct antiquated methods of primitive man. Satisfaction of immediate physical needs was the goal of primitive man, which was attained soon enough. But now it is unbounded ambition, which covets more the more it attains. It is a palpable demonstration of the effectiveness and the far reaching effects of the new method, the power of brain over brawn.

As citizens of a small country, ladies and gentlemen, your duty and your responsibility is therefore greater, to seek to protect and conserve for posterity what you now have. Cultivate efficiency along your chosen lines of work so you may hold your ground against competition; keep abreast of your profession by constant study; meet your opponents in the ruthless struggle with the same effective tools that they possess; meet cunning with cunning, diligence with diligence, astuteness with astuteness, but withal be honest in all your dealings. You have the initial advantage in that you were born and raised in your field of endeavor. You have one great disadvantage, however, in that you are not keyed up to meet the rigorous competition which only generations of struggle can bring about. This is your greatest handicap. With exotic people coming to our shores, and our own population increasing by leaps and bounds, we shall soon have enough of the latter. And may the best win!

ABSTRACT[1]

Plows and Plowing—II, A Study of Some Typical Filipino Native Plows, A. L. Teodoro (Philippine Agr., 14, 1925, No. 3, pp. 135–142, pl. 1, figs. 2).—A description is given of the mechanism and construction of the various parts of different native plows, and the action of these parts is briefly analyzed with reference to quality of work and of draft in the act of plowing. While the implements investigated are apparently quite primitive, it is stated that native farmers find them to be very simple in construction, very light, and easy to manipulate. They can also be used conveniently to plow out corners of small fields. The general purpose plow is designed to break up the surface of the soil in first plowing rather than to pulverize it, and it is necessary to plow at least twice before a mellow seedbed can be produced. All the parts composing the plow, aside from the moldboard and share, are made of wood, which presents the advantage that the wooden parts either break or spring back to their original positions when subjected to stress.

[1] *Reprinted* from *Agricultural Engineering,*—the journal of the American Society of Agricultural Engineers (A. S. A. E.). Vol. 7, No. 1. January 1926. Page 26.

EXCHANGE NOTES

Although included among its eight thousand graduate and undergraduate students there are representatives of all the states in the Union and of thirteen foreign countries, Wisconsin is still primarily the university of and for the great agricultural state which supports it. Seventy-five per cent of its men students and sixty-four per cent of the women belong to Wisconsin. A large majority of the others come from the surrounding states, where life and environment are the same as in Wisconsin.

Out of a recent graduating class from the university's School of Agriculture ninety-five per cent of the students returned to the Wisconsin farms from which they had come, there to live and work and apply the teaching which the state had given them. Incidentally, the students in the School of Agriculture have a higher average scholastic standing than those of any other department of the university. The comparative academic ratings of the different departments for a recent semester were: Agriculture, 1.429; Letters and Science, 1.213; Engineering, 1.204; Law, 0.908.

The students of agriculture carry back to the farms far more than the mere technical information essential to the more productive use of their lands. Plus that, they receive the liberalizing cultural courses which give

them the mental resources for the enjoyment of life, if they choose to use them.

It is the strong, wholesome flavor of the farm and of the small Wisconsin town, only one remove from the farm, that still characterizes this university.—CHARLES R. SELDEN.

—*Ladies' Home Journal.*

Farmers can save their farm buildings, brighten up their homes, and increase their credit and self-respect by using paint, points out a publication of the Tennessee College of Agriculture. Paint prevents decay by keeping out the moisture and air, while white lead, if it is used, poisons the wood fibre so that the fungus cannot live on it.

—*Agricultural Gazette* (New South Wales).

The word alcohol is strictly applicable to a number of distinct though allied liquids and solids.

The alcohol with which we are here concerned, is the one contained in potable spirits viz: Ethyl Alcohol, which may be defined as a decomposition product of the carbohydrates, i. e., celluloses, starches and sugars.

The carbohydrates form over 90 per cent. of the dry matter of the vegetable kingdom. They embrace sugars, starches and celluloses and are so called because they contain carbon together with oxygen and hydrogen combined in the proportions in which these latter two elements combine to form water. Sugars are the simplest carbohydrates, while starches are more complicated in structure and cellulose still more so. Some sugars e. g. glucose can be fermented direct to alcohol by means of yeast, others like cane sugar have to be "inverted" first, while starches have to be converted first into sugar by enzymes such as diastase (found in malt, etc.) or by treatment with acids; celluloses have to be treated at high pressure with strong acids before they can be fermented to alcohol (N. B.—Biological methods of conversion may be discovered at a later date).

Theoretically a sugar such as glucose on fermentation yields 51.1% of its weight of alcohol, while one of the cane sugar type yields slightly more and starches should yield more. In practice however it is not possible to obtain the amount indicated by theory, part of the alcohol being converted to acetic and ethyl acetate, by secondary reactions.

—*The Planter* (Kuala Lumpur, F.M.S.).

The production and consumption of rayon in the United States continued their steady growth during the current year. The output of the American plants for the first half of 1925 is given by the Silk Association of America as slightly over 24,000,000 pounds.

Rayon is also being produced in increasing quantities in practically all of the important manufacturing countries of the world.

—*Commerce Reports* (U. S. Dept. of Commerce).

Swiss chard is an excellent plant for greens. Anyone not familiar with it who is fond of greens, will find a very delicious vegetable. The culture is very simple requiring about the same as the beet. Bugs do not bother it very much. It stands drought or excess rain, makes fine tender greens all summer and fall—and then, if desired, may be had fresh and green during the winter also.

As soon as the leaves are large enough to use they may be cut quite close to the ground, as this does not injure them particularly. If left to grow without cutting, the plants will grow to enormous size. The mature leaves have a heavy white rib. This is very good cooked just as one does asparagus. . . .

Then, too, one may take up several of the plants, root and all, with what dirt clings to them and place them in jars and set in the cellar. Have enough water in the jars to cover roots and replenish as it evaporates. Several plants may be placed in one large jar, but do not crowd the roots too much. After a short time they will send out tender blanched leaves.

—*Successful Farming.*

Last summer I whitewashed over concrete blocks in a basement with two-thirds white plaster, one-third hydrated lime, mixed to consistency of paint, applying with a paste brush (any kind will do). Water came in on this and when it dried out it was white and did not rub off.

—*The Prairie Farmer.*

COLLEGE AND ALUMNI NOTES

The "World of Science" by Dean Baker which appeared on editorial page in the January number of THE PHILIPPINE AGRICULTURIST, was reprinted in the Peking Union Medical College *Weekly Calendar.*

During the second week of February Dr. H. L. Russell, dean of the College of Agriculture, of the University of Wisconsin, was on the Campus. He was here in the interests of the International Education Board, making a study of the various agencies and personnel that are carrying on research in the pure and applied natural sciences. Dean Russell was accompanied by his secretary, Mr. Smith. The resources, staff, nature, quality and quantity of the research were all being examined critically, as a part of a study of a number of countries lying about the Pacific. Japan and China

had been studied in more or less detail, and from the Philippines the itinerary was to take the party on through Siam, the Straits Settlements, the Dutch East Indies, Australia, and New Zealand, and thence back to the United States, the entire study consuming a full year.

It was unfortunate that the disturbances about Canton, China, prevented the party from reaching that city and so studying the work of Canton Christian College. The scientific work that is being conducted in the several countries in this part of the Orient suffers severely by the isolation caused by the methods and routes of transportation, as well as by the barriers of language, not to mention the lack of resources of the individual workers and their institutions. An example of such a barrier is the lack of a satisfactory line of passenger steamers that calls at both Indo-Chinese and Siamese ports on the Singapore route. This resulted in Doctor Russell's failure to visit Indo-China. So the International Education Board will not have first hand information about the considerable amount of good research work that is being conducted in the progressive French colony.

Some co-ordinating agency for the scientific work is very much needed, and it is hoped that the present study will be an important contribution toward the establishment of closer relations between the scientific institutions and their workers.

Note in letter to Dean Baker from Dean Russell when he was in Buitenzorg, Java:

> I find the attitude of the men over here very sympathetic toward research. While as yet they have done little along teaching lines, from the research point of view they are well advanced. We are having quite a gathering of scientific fellows here at our hotel. Dr. Pemberton is here, also Dr. Taylor of the Fiji government who is engaged in parasite hunting, and Dr. Reinking formerly of your staff. Reinking is chasing up bananas resistant to banana wilt and expects to spend a long time in the archipelago.

A recent campus visitor was Hon. E. Nuida, Consul General for Japan in the Philippines.

Professor M. W. Senstius, of the Department of Geography of the University of Chicago, was on the Campus for a number of days between February 10 and 20. Having previously been stationed in scientific work in Java for a number of years, he had just been spending sabbatical leave there, and when here in the Philippines was on his way back to Chicago to resume active teaching and research. While in the Islands he climbed Mounts Maquiling, Banahao, and Santo Tomás, the last-named being near Baguio. One of the main questions being investigated was the relation of the tropical soils to the climatic and other factors that affect their nature and fertility. Professor Senstius was also interested in the similarities and differences between our flora and that of Java.

Mr. Eikichi Iso, expert in Agronomy from the Government Research Institute in Formosa, visited the College in April. Mr. Iso is in the Philippines to study our agricultural conditions, especially rice production.

Mr. Jenkin W. Jones, superintendent of the Rice Experiment Station at Biggs, California, visited the College of Agriculture in the latter part of January. Mr. Jenkins conferred with Dean Baker and other members of the faculty.

Miss Elsie Wilcox, Commissioner of Education on the island of Kauai, T. H., Miss Nell Findley, Welfare Worker with the Hawaii Sugar Planter's Association, and Mr. and Mrs. Hugo Miller, were campus visitors in March. Mr. Miller is Ginn and Company's representative in the Philippines.

The College of Agriculture students receiving degrees at University of Philippines Commencement Exercises, March 23, 1926, were:

Bachelor of Agriculture
(General Curriculum)

Isidoro A. Andaya
Tomás Bandong
Cipriano P. Barbon
Gregorio R. Briones
Victor Burgos
Valeriano C. Calma
Nicanor M. Castillo
Emilio T. David
Catalino E. García
Gregorio Goco
Gabriel B. Gonzalez
Federico Goseco
Mateo D. Jimenez
Isidoro L. Madjus
Paulino Menor
Toribio Mercado
José C. Ramos
Eligio J. Tavanlar
Edmundo G. Yasay

Toribio Mercado was awarded by College of Agriculture Faculty the Class '25 Gold Medal for the best thesis presented.

(Annual Husbandry Curriculum)

Sotero P. Lantican
Pastor V. Maclang
Celso S. Tuason

Bachelor of Science in Agriculture
(General Curriculum)

Dionisio A. Calvo
Ignacio O. Dres
Pedro Portigo Porquez
Angel R. Relis
Dioscoro V. Retiro
Luis S. Sol de Villa

(Animal Husbandry Curriculum)

George Khomson, from Lampang, Siam

(Supplementary Curriculum)

Eusebio Bataclan, B. Agr. '24
Alejandro Bautista Catambay, B. Agr. '24
Moisés M. Kalaw, B. Agr. '25
Macario Anoran Palo, B. Agr. '24
Juan Rostrata Pronto, B. Agr. '24
Leopoldo Genteroy Salazar, B. Agr. '25
Clemente Elima Yango, B. Agr. '24

Mr. Mariano Mondoñedo, B.S.A., Iowa State College, and instructor in animal husbandry in this College, completed the work in Veterinary Medicine in College of Veterinary Science and was granted the D. V. M. degree on March 23.

Dr. Robert L. Pendleton, of the Soil Technology Division, left the Campus on April 10 to continue the studies of the soils of the island of Negros that were commenced last year. In connection with Dr. M. L. Roxas and Mr. G. H. Pritchett of the Philippine Sugar Association, a study is being made by that association of the sugar cane producing soils and the fertilizer and other field experiments that have been conducted thus far, in an endeavor to gain a better and more comprehensive understanding of the soils of the island and their crop producing power and fertilizer needs. A reconnaissance soil survey will be a part of the study.

Miss Margaret C. Wilson of English Department spent the vacation weeks in China with friends.

Dr. Valente Villegas and Mr. F. B. Sarao of the Department of Animal Husbandry visited the Boñgabong (Nueva Ecija) Stock Farm of the Department of Agriculture and Natural Resources and the Central Luzon Agricultural School at Muñoz, March 16 to 19.

Mr. Melencio M. Manio, B. Agr. '19, was a welcome visitor at his old College in April. Mr. Manio is instructor in biology in Nueva Ecija High School, San Isidro.

The total enrollment for the Summer Session of the College was 296. Of this number, 38 were new students, 27 being high school graduates. The practical short course (without credit) in poultry raising was given again this year, five taking the course were farmers. For the first time a special course (without credit) was given in agronomy for teachers in agricultural public schools; six teachers were enrolled in this course.

The Los Baños Biological Club held the last scientific meeting of the College year on the evening of March 4, presenting the following program:

"Worm Parasites of Philippine chickens: their treatment and control" —by Dr. M. A. Tubangui.

"An interpretation of the physogenetic significance of the feeding habits of certain mandibulate phytophagous insects"—by Dr. L. B. Uichanco.

Annual Report of the President of the Club, Dr. N. B. Mendiola.

Remarks, by Dean C. F. Baker.

An article, "Jute in the Philippines; it is Abundant," by Vicente Aldaba of the Fiber Division of the Department of Agronomy, appeared in the March number of *The American Chamber of Commerce Journal*. Two illustrations added to the interest of the paper.

A most interesting and informative article, "Mexican Agricultural Production," by Evett D. Hester, formerly Registrar of this College and Head of Department of Economics, appeared in *Commerce Reports* (U. S. Dept. of Commerce) for February 22.

One of the results of the revival of tennis among the Faculty is the construction of a second tennis court just south of the original court near the Forestry Mess. The one court did not offer sufficient accommodation for the many players.

A copy of *Farthest-North Collegian*, the publication of the Alaska Agricultural College and School of Mines, was recently received. This College, which can boast of being located nearer the North Pole than any other institution for higher education, is in Fairbanks, Alaska. As we are the "farthest-south" College of Agriculture under the Stars and Stripes we have a feeling of peculiar friendliness for our sister college in the Northland.

The College opened in 1922 with six students, its enrollment now is about 200. An article in the journal on the library mentions their 5,000 volumes. Among the leading articles are: "In the Beginning" by Mrs. Luther C. Hess, a member of the Board of Trustees since the organization of the College. In this article Mrs. Hess traces the history of the College. "One Day of It"—by a graduate of the college, now wife of a biological explorer, gives a graphic description of one day's travel north of the Arctic Circle. "The Future of our School of Mines,"—includes a succinct account of the development of other Schools of Mines.

The Forest School quarterly, *The Makiling Echo*, under date of April contains much of interest. An article (reprinted) on "Facing the Problem of the Forests" by Colonel George P. Ahern, founder and for several years director of the Philippine Bureau of Forestry, is of unusual interest and value.

The reception by the faculties of the College of Agriculture and College of Veterinary Science to the seniors in the evening of March 13 on the lawn of the Y. M. C. A. was a very pleasant affair. The brilliantly lighted lawn was made gay and festive with bunting, red lanterns, palms, and flowers.

The most impressive feature of the evening was the Procession. In the "Y" Hall each senior gave a lighted torch to a member of the faculty who escorted the senior to an arch which formed a gateway to the lawn. On the outside of the arch were the words "Dreams of Youth," on the inside "Life's Realities." At this gate stood "Father Time" (Dean Baker). With a few fitting words each faculty member when he reached the gate, presented the senior whom he escorted to Father Time, who, solemn in mien and serious in tone, uttered prophecy as to this senior's work in Life's University. Then the torch was passed to the senior who must henceforth light his own path. There was appeal, dignity, and beauty in this symbolic procession.

Later in the evening, with Dean San Agustin of the College of Veterinary Science presiding, Dean Baker gave one of his characteristic talks to the senior's; Doctor Gonzalez addressed the classes, taking as his theme, "What students learn at these colleges outside lecture halls and laboratories". There were brief addresses by Mr. C. del Rosario, president of the College of Agriculture Class of '26, and by Mr. Alcid, president of the College of Veterinary Science Class of '26. There were class wills by each class.

Selections by the College orchestra, and singing added to the pleasure of the evening.

In the evening of March 6, the Class of '26 gave a benefit entertainment in the College Auditorium. Though neither "fish nor fowl nor good red herring" that is, it was not a concert, not drama, not vaudeville, it was, for the most part, good fun, as was evidenced by the applause and laughter of the packed auditorium.

The director was C. del Rosario, stage manager, Luis Sol de Villa.